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s Hand Books of the Farm.

NO. III.

THE CROPS

BY

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HANDBOOK OF THE FARM SERIES.

EDITED BY J. CHALMERS MORTON.

EDITOR OF THE "AGRICULTURAL CYCLOPÆDIA;" THE "AGRICULTURAL GAZETTE;" THE
"FARMER'S CALENDAR;" THE "FARMER'S ALMANAC;" "HANDBOOK OF THE
DAIRY;" "FARM LABOURER," ETC.

MORTON'S HANDBOOKS OF THE FARM.

No. III.

THE CROPS.

BY

house
T. BOWICK, J. BUCKMAN, W. T. CARRINGTON,
J. C. MORTON, G. MURRAY, J. SCOTT.

SIXTH EDITION.

LONDON:
VINTON & CO., LTD., 9, NEW BRIDGE STREET, E.C.

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The present volume is one of a series discussing the Cultivation of the Farm, its Live Stock, and its cultivated Plants, Farm and Estate Equipment, Dairying, and Farm Labour, the Chemistry of Agriculture, and the Processes of Animal and Vegetable Life. Among the writers who have been engaged on them are Messrs. T. BOWICK, the late W. BURNES, GILBERT MURRAY, the late W. T. CARRINGTON, the late Rev. G. GILBERT, Messrs JAMES LONG, W. J. MALDEN, J. HILL, SANDERS SPENCER, and the late J. C. MORTON, Professors G. T. BROWN, J. WORTLEY-AXE, and J. SCOTT, the late Professor JAMES BUCKMAN, Dr. MAXWELL T. MASTERS, F.R.S., and Professor R. WARINGTON, F.R.S.

PREFACE TO FIRST EDITION.

The present volume, aiming at covering the whole field of plant cultivation so far as the farm is concerned, gives necessarily but short and scanty notices of the many exceptional crops known only in particular districts. The general subject of grass land management, the process of laying down land to permanent pasture, the subject of crop rotations, and the cultivation of the principal crops known to English farmers:—all these are, however, treated in it with fulness enough to equip it as a memorandum-book for the farmer. And there is a chapter on the Weeds of the Farm which also well deserves his consideration. A large portion of the book was written by the late W. T. Carrington, of Croxdon Abbey, Uttoxeter, whose chapter on Grass Land management has been supplemented by Professor James Buckman, of Bradford Abbas, near Sherborn. The chapters on Rotation of Crops and on the Weeds of the Farm have been

written by Professor J. Scott, of the Royal Agricultural College. Mr. T. Bowick, of Bedford, and Mr. Gilbert Murray, of Elvaston, near Derby, have contributed several of the descriptions of the principal crops of the farm; and thanks are due to Mr. C. Whitehead, of Maidstone, for his revise of the articles on Hop Culture and Market Gardening.

J. C. M.

PREFACE TO FIFTH EDITION.

The chief addition is a new chapter on Ensilage, from the pen of Mr. R. Henry Rew.

April, 1892.

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THE CROPS OF THE FARM.

INTRODUCTION.

OF the 56,786,199 acres which are included within the area of Great Britain, 32,918,514 acres were in 1891 returned as being in agricultural occupation. Of these, 16,433,850 acres were in permanent pasture, exclusive of moorlands and commons; 4,716,582 were in clover, sainfoin, and grasses under rotation; 3,297,569 acres were in green crops; and 7,924,823 were in grain crops. Besides these, there were smaller areas in flax and hops, market gardens, &c.; and 429,040 acres were in bare fallow. If Ireland be added in, the figures for the whole United Kingdom become 48,179,473 acres in occupation, 27,569,663 in permanent grass, 6,013,685 in clover and grasses under rotation; 4,510,653 in green crops, and 9,443,509 in grain crops.

These figures sufficiently illustrate the relative importance of the crops of the farm in this country. We have to describe the cultivation of the plants which make up more than 27,000,000 acres of permanent pasture, 2,392,245 acres of wheat, 2,298,978 acres of barley, 4,128,127 acres of oats, 60,148 acres of rye, 359,039 acres of beans, and 204,972 acres of peas. And

in addition to the permanent pastures and the corn crops of the country, there are, as already said, 6,013,685 acres of clover and grasses in rotation, and there are 1,296,763 acres of potatoes, 2,227,050 acres of Swedish and common turnips, over 400,000 acres of mangel würcel, 18,000 acres of carrots, 207,260 acres of cabbage, kohl rabi and rape, and 372,630 of vetches and other green crops, not including clovers and grasses.

The cultivation of all these crops and plants comes within the scope of the present handbook. It is plain that there is not room for a very elaborate discussion of each, but an attempt will be made to relate the principal facts in the year's history of each, and so far to describe its cultivation, that the reader may know the characteristics of the several varieties of each crop, the soils which they severally affect, and the circumstances and treatment under which a satisfactory produce may be anticipated. Little will be said of the scientific classification under which the relationships of cultivated plants among themselves and to other plants is expressed. They will be named and described pretty much in the order of their importance, as indeed they are enumerated in the statistical table of the Board of Agriculture, from which we have extracted the figures indicating the area of each which we grew in 1891.

It is plain that under this rule of arrangement the permanent pastures of the country properly claim the first place in our discussion.

CHAPTER 1.

PERMANENT PASTURE.

Description.—Composition.—Practical Management.—Grazing.—Mowing.—
Manuring.—Weeding.—Haymaking.

THE area coming under this division of our cropping, though proportionately larger in extent on the western and northern sides of the island, embracing all its wetter districts, includes soils as various in quality and character, and degrees of fertility as wide apart, as any known in arable farming. The clay lands tend rather to be selected for the growth of grass, because of the burden of labour-cost which in their case attends arable cultivation. And for the same reason—the increasing cost of labour—the whole area of pasture land in this country is gradually and has been of late years even rapidly increasing. But lands of all kinds, chalky, sandy, loamy, clayey; all furnish their contingent to the pasture area of the country. It is a great advantage to all farms of whatever soil to have a certain proportion of permanent pasture. And thus every county contributes a large proportionate area to the total.

The value of the annual produce depends here as on the plough-lands of the country, on the quality of the soil and the management of the crop. Pastures are indeed quite as amenable to treatment as ploughed fields. Continuous manuring of any one kind rapidly changes the character of the grasses and other plants covering the

ground. Continuous mowing or continuous depasturing, continuous treatment of any kind indeed, favouring as it does one set of plants rather than another, ultimately gives them the advantage in the perpetual contest of growth which is maintained among them, and the result is soon visible in the altered character of the vegetation.

Description.—It is of course on the presence of the better and more nutritious grasses and clovers and the fitness of the soil and circumstances to luxuriant growth that the value of any pasture depends; and the composition of a bit of good turf is thus the principal index to the value of the field. The vegetation is made up largely of grasses, somewhat of clovers, and also to some extent, of weeds.

Pasture grasses are those smaller perennial species usually associated in meadows which are grown for their herbage: corn or cereal grasses being the larger kinds cultivated for the sake of their seeds.

In a good meadow the mass of the herbage will consist mainly of the following nutritive and palatable grasses:—

<i>Lolium perenne</i> .	Rye grass.	<i>Phleum pratense</i> .	Catstail, or
<i>Festuca pratense</i> .	Meadow Fescue.		Timothy grass.
„ „	var. <i>lojiacea</i> .	<i>Anthoxanthum odoratum</i> .	Sweet
„ <i>laeviuscula</i> .	Hard Fescue.		Vernal grass.
„ <i>ovina</i> .	Sheep's Fescue.	<i>Dactylis glomerata</i> .	Cocksfoot
<i>Poa pratensis</i> .	Smooth Meadow		grass.
	grass.	<i>Avena pubescens</i> .	Hairy Oat-like
„ <i>trivialis</i> .	Rough meadow grass.		grass.
<i>Alopecurus pratensis</i> .	Foxtail	„ <i>flavescens</i> .	Yellow Oat-like
	grass.		grass.

Here are a dozen species which will be found to prevail in differing proportions in most good pastures: and the following is a list of those which indicate a poor condition of herbage—the result of inferior soil and climate.

<i>Aira cæspitosa</i>	Tussac grass.	<i>Brachypodium sylvaticum.</i>	False
<i>Avena pratensis.</i>	Oat grass.		Brome grass.
<i>Poa aquatica.</i>	Water Meadow-	„	<i>pinnatum.</i> Barren
grass.			do. do.
„ <i>aquatilis.</i>	Floating do. do.	<i>Festuca elatior.</i>	Tall Fescue grass.
<i>Agrostis alba.</i>	Fiorin grass.	<i>Bromus mollis.</i>	Soft Brome grass
<i>Alopecurus geniculatus.</i>	Bent-	„ <i>asper.</i>	Rough do. do.
stemmed Foxtail grass.		„ <i>giganteus.</i>	Giant do. do.
<i>Hordeum murinum.</i>	Wall Barley.	„ <i>sterilis.</i>	Sterile do. do.
<i>Briza media.</i>	Quaking grass.	<i>Triticum repens.</i>	Couch grass.

If we add to this list of rough grasses, *Carex* or sedge of various forms, and different species of *Juncus* or rush, we have an assemblage which as clearly points to a bad condition of pasture as the first list does to a much better state of things.

The reader should get acquainted with the characters of the plants given in these two lists; and this he must do for himself by studying them in the field during May, June, and July when in bloom; the inflorescence then enabling him to recognize them in the engravings which will be found in any seedsman's trade list.

It ought, however, to further interest him to remark that, while the first list will be found to mark good herbage, yet even in our best fields a ditch or a bit of disordered drainage will not fail to afford the botanist some specimens, it may be poor examples, of species in the second group. And in like manner starved specimens of the first list will occur here and there in very poor fields. In fact a continual struggle for survival is carried on between the good or "sweet" grasses, and the rough or "sour" ones, the issue of which depends on the circumstances of each case.

When we examine any mixed pasture we shall conclude

THE CROPS OF THE FARM.

that the plants present in it are in various conditions as to vigorous growth and cultivation — various states of prosperity, some developing, while others it may be are declining. And if we neglect to drain, weed, manure, and roll our meadows, we neglect the proper cultivative agencies, which are calculated to maintain their prosperity and excellence, and they will gradually relapse into a more or less wild state.

The best turf, then, is that which is composed of the best sorts of grasses, such as compose our first list; and these may be in good or bad condition, according to the state of cultivation. When only good grasses prevail, the crop of hay will be of the best quality and of the greatest yield. But as a rule few meadows are made up wholly of grasses; and all good natural pastures have also a varied collection of other plants, which differ greatly according to the nature of the soil and the state of its cultivation. Amongst these we enumerate the following as some of the most important:—

<i>Trifolium pratense.</i> Broad Clover.	<i>Trifolium repens.</i> Dutch Clover.
(In rich pastures.)	(In medium soils.)
„ <i>medium.</i> Zigzag Clover.	„ <i>fragiferum.</i> Strawberry.
(In sandy soils.)	headed Clover. (In wet soils.)

And besides these, which are invariably present in good grazing grounds; there are in all grass land as in all arable land many weeds. They are more frequent in poor pasture than in rich grass, and much more frequent in lands annually mowed, than in lands which are annually grazed. There is less opportunity in the latter case for their seeding and propagation. The following are the most important:—

The Daisy, Cowslip, Purging Flax, Rest-harrow, and Orchid, are a sign of poverty.

The Lousewort, Betony, Devils-bit-scabious, and Spear-leaved Ranunculus, indicate wet soils.

Nettles, Thistles, Docks, Foxglove, Fern and Gorse, indicate lax cultivation.

The common Rush, and various species of Sedge, indicate poor wet soils.

Practical Management.—Owing to this variety in the character of its herbage and the varying circumstances out of which it has arisen, the value and capabilities of grass land vary very greatly in England—between the extreme of the poor hill pasture, adapted only for mountain sheep, and worth little more than 5s. per acre, and the richest feeding land to be found in some of our river valleys in Somersetshire and elsewhere, and worth more than as many pounds per acre.

Many considerations affect the question of the most profitable mode of managing pasture land in any given locality. The climate and soil, the position of the land with regard to railways and markets, and the existence of any special demand for live stock or for its produce of any description, the healthiness and suitability of the land for breeding, feeding, or dairying cattle, or for breeding or fattening sheep, the supply of labour, all need to be taken into account.

Strong rich pastures producing succulent grasses abundantly, are well adapted for fattening large cattle either without any extra food, or with the aid of a little cake. Second rate pastures, especially if on a cold subsoil, will generally yield a better profit from the dairy, and from the rearing of young cattle. Dry hilly pastures are most suited to sheep. The grazing of land by a mixed stock of cattle, sheep, and horses, results in the land being more evenly grazed than where one kind only is kept. Where,

however, many sheep are grazed with cattle, as they pick out all the finest of the grasses and clovers with their narrow noses, the cattle will not thrive so well. But sheep, on the other hand, eat with avidity and impunity many weeds which cattle dislike and avoid, such as the common buttercup, the hard head, and the cowslip. Many pastures grazed only with cattle are in spring time perfectly yellow with buttercups, which a few sheep mixed with the cattle would keep down. Horses when kept in a pasture to themselves are very unlevel grazers, but a few kept in a large cattle pasture will graze the rank places where cattle have left their manure, and about gateplaces where the land has been trampled. Both horses and sheep will thrive much better when they are able to select their own food.

Different opinions exist as to the propriety of pasturing land in the winter months. As a general rule, it is doubtless wrong to let cattle have access to all the pastures throughout the winter. Pastures cleared at Christmas or earlier will undoubtedly have a better start in the spring. In a grass land district, however, where straw and roots are scarce, and there is a deficiency of buildings to house all the stock, breeding and young cattle may with advantage be allowed to run upon sound and well sheltered grass fields in the winter months. The pickings of grass, and their own exercise in getting them, are beneficial to the cattle, and if they be at the same time supplied with cotton cake or other food rich in manure value, the fertility of the pastures will be increased.

It is better not to graze pastures very closely in any season of the year. Pastures when bare are much more likely to suffer from either drought or cold than when covered with grass two or three inches deep, and they grow

much more slowly. All plants feed from the leaf as well as the root, and when cropped too closely the power of drawing nourishment and attracting moisture from the air is much lessened. Young turf requires specially careful grazing; but it must be remembered that if allowed to get ahead in the early summer, it becomes overgrown and benty, and is rejected by cattle and sheep. And the after-growth of grass is hindered throughout the year by the old dry grass remaining on the land.

In managing grass land to the best advantage, the occupier should keep a sharp eye upon the thriving of his stock, and by change of pasturage when required, or by giving supplementary foods, strive to keep his animals always improving. It is not desirable unduly to feed or "force" either cows when heavy in calf, or breeding ewes, as the risk of loss is thereby increased; otherwise it may be taken as an axiom that unless young or feeding cattle or sheep are growing and improving in condition from week to week, they are paying nothing for what they consume. By the judicious use of feeding stuffs either for cows or for fattening or young cattle, or for sheep, the grass land may be more evenly grazed, and its fertility increased, in the most economical manner. Decorticated cotton cake is a valuable food for use in grass feeding. It can often be bought at less than the theoretical manure value which it possesses after consumption by stock.

Great improvements have been made in many pastures by drainage and top-dressing with bones, lime, guano, or other manures—a subject which will be treated of in another handbook, under the head of draining and manures.

Coarse weeds growing on pastures may be checked by

mowing. The burr thistle should always be spudded beneath the crown of the plant. The common thistle may also be most thoroughly checked by persistent spudding or drawing; but in those pastures where it is very abundant this would be an endless task, and mowing is resorted to before the thistle is fully in flower. Fern may be entirely destroyed by repeated mowing and top-dressing of manures calculated to force a thick growth of grass. Nettles which are a sign of high condition, and often indicate the former site of a garden, may also be destroyed by repeated mowing.

Grass land should be well grazed down in the early part of the summer, as if left to grow too long it becomes unpalatable to stock. In a very growing season, when grass gets ahead, and stock cannot be bought with a prospect of paying for their keep, the long grass which remains should be mown off and made into hay in July or August, whenever the weather is suitable.

In some districts the custom prevails of mowing and grazing in alternate years. In practice it is found that this has not much to recommend it: and it is often an excuse for mowing land without properly manuring it. Land that has long been mown yearly and well manured, puts up varieties of grasses which grow up and ripen together about mowing time in June or July better than the grasses of an ordinary pasture will do. Nor will a field generally mown graze as evenly as a regular pasture. Many meadows are specially adapted for the growth of grasses for mowing, either from being capable of irrigation, or from being on a cool subsoil. When a meadow is on a shallow though not on a dry subsoil, it will, although well manured, fail to yield a good crop for hay in a hot, dry

spring and summer, the flower stalks pushing up without much bottom grass. And such lands will generally be better grazed.

In districts where there is a large proportion of arable land the meadows are often in poor condition. The whole of the farm dung is used on the plough land, and the meadows may be dressed with lime and soil, or other weak composts. This is, however, not true economy. Where farm dung cannot readily be spared, or where it would have to be carted a long distance, or up steep or difficult roads, its place may well be supplied by 3 cwt. per acre of Peruvian guano, or 1 cwt. nitrate of soda and 3 cwt. of mineral superphosphate, or 5 cwt. of bone manure, any one of which dressings can be applied to the land at a cost of about £2 per acre—a sum often spent in labour alone, in carting, spreading, &c., a very poor top-dressing of farm dung.

It is always best to secure an even crop of grass all over the land, the cost of mowing and haymaking not being proportionately greater with a full crop than with half a crop. By dressing all weak spots in a meadow at the end of April, when they may be detected, with a light dressing of nitrate of soda or guano, this result may be obtained. Farm dung is best applied to the land either immediately after the hay is cleared, or in early autumn, after the early growth of aftergrass has been fed off. Ten or fifteen cart-loads per acre, equal to nearly as many tons, is a good dressing. It may also be applied any time in the winter, but with generally an inferior result than is realised from an earlier dressing. The dung, after being spread, should be chain harrowed once or twice. If not got on before spring, and a dry season comes, the crop will be injured rather than benefited by it.

Where the mowing meadows lie in such a situation and form that they can be readily irrigated with water either of naturally fertilizing quality, or mixed with sewage, they may be beneficially flooded in the winter and spring. The drainage from the farm buildings and yards, when collected in cesspools and mixed with sufficient volume of water to flow when flushed off by gravitation over a considerable area of land, will be very beneficial, and will produce heavy crops of somewhat coarse grass. When from the position of the farmstead, or the scarcity of water, this cannot be done, the liquid manure should be collected into a tank, the rain water being excluded, and carted out in showery weather to the nearest meadow or other field requiring manure. It will not pay in this country to make any large outlay for irrigation works. Much catch water from land drainage and brook and river water is of little benefit except in a very dry season, and any outlay required to secure the use of it must be kept within moderate limits.

In districts where the climate and soil are unsuited for the consumption of roots by sheep on the arable land in the winter months, they may be consumed on the meadows; and if cake and corn be freely given, and the troughs regularly moved over the fields, the meadows will be put in high condition, a thick-set fine herbage being obtained in great abundance, with a better result in quality and quantity of produce than can be obtained by any other method of manuring.

Where meadows are only in moderate condition, it may be desirable to clear them of stock by Christmas, or very early in spring. If the meadow be on a warm soil, it is specially desirable to get the land well covered with grass

before hot weather comes. Meadows in very high condition on a cool subsoil can be grazed even in April without risk ; six to eight weeks being amply sufficient for a full growth of hay. Meadows and clover set apart for mowing require to be looked over in the spring, all sticks and stones being picked off, and then to be rolled. This is the more necessary now that mowing machines are in general use.

As to haymaking, the proper time to cut grass in rotation is when the blossom appears on the rye-grass, and the clover is coming into general bloom. This will generally be in early districts in the south of England at the end of May or the beginning of June ; in the midland counties during the middle of June ; and in the north at the end of that month.

Meadow haymaking will generally immediately follow, and should be begun when the majority of grasses are in flower. If, however, the crop be very heavy, and the weather likely to prove fine, it is better to cut before the grass is ripe, as otherwise it will become coarse at bottom.

When grass is cut too soon, though it will make hay of fine quality, it shrinks up too much in drying. When it is overgrown the hay is coarse and innutritious, the growth of aftermath is retarded, and if the crop be heavy, the finer grasses are smothered, and a coarser future growth induced ; especially is this the case in irrigated meadows. The practice, common in many districts, of allowing the aftergrass to be fully grown before turning stock in, also causes a coarser growth. It is most important "to make hay while the sun shines." If therefore the weather be wet and unpromising, it is better to delay cutting much grass until there is a better promise.

By the aid of mowing machines a large breadth may soon be cut. These machines are a great boon to the grass farmer; they have been greatly improved, and the best of them are now admirably adapted to their work, cutting even the heaviest crops better, and at less cost, than can be done by the scythe. A good driver with a pair of active horses can cut from seven to ten acres of good grass, leaving an almost perfectly close and even surface.

When clover and rye-grass are cut, the common practice in many districts is to turn the swathes over two or three times at intervals; and in four or five days, if the weather be brisk and the crop not very heavy, it is put up in large cocks and carried to the stack. When the crop is heavy, it is better to spread the swathes while they are green over all the land, turning it in one or two days with the rake in rows as large as the rake will turn easily at once, turning this again, keeping it in rows with the rake, and putting it up in cocks when it is dry. These cocks, being placed two or three together when nearly made enough, or if rain threatens, will resist a moderate quantity of rain: and when there is a probability of a few hours' sunshine, they can be opened, and if fit, carried to the stack. In getting clover, it is necessary to avoid roughly shaking it after it is once withered, as much of the leaf is thus broken and lost. Tedding machines, though most valuable in getting meadow hay, are, therefore, of little use in getting clover hay. It is difficult to give trustworthy directions as to when clover and hay are fit to carry. It is a knowledge which can only be gained by practical experience. Much depends upon the size of the stack and the nature of the grasses and clover. The thick succulent

stalks of red clover take much drying, and the grass of irrigated meadows, which is of a soft nature, is also very apt to heat in the stack.

On level meadows the hay tedder is a very useful machine, though it is sometimes overmatched by a very heavy crop of soft grass. The swathes may be teded with the machine soon after cutting, and turned the day following, if the weather be fine, by the same machine with reverse action. After the first operation the hay should never be thrown over the machine, as it shakes the seeds out. If the crop be heavy the first turning will be best done with the hand rake, as this brings to the top any locks of grass which the machine may have left unstirred, and it leaves the half-withered grass in a good form for the machine to work over again. If the weather be precarious, or in any weather if hands can be spared for the work, all hay more than half made should be drawn into rows with the hand or horse rake, and made into cocks in the evening. It will thus be kept from whitening by exposure to night dews or rain; and three or four small cocks placed one upon another will resist much rain. In very fine, settled weather these precautions are not so important. It is, however, true that the less hay is exposed to dews, or even to scorching sun, the better will be its quality. The finest hay is made in dry, sunless weather. When hay is fit to carry, every effort should be made to secure it, other operations giving way for it. The horse rake is a very useful implement, both for gathering the hay into row and raking the land clean after.

In districts where a large acreage of hay is got, straw is scarce and dear, and thatch is sometimes worth as much as £5 per ton. Hay barns, either of a durable character, on

pillars of iron, wood, or brick, and with roofs of slate or iron, or of a more temporary nature, and roofed with boards or asphalte, are therefore becoming general. The advantages of them are obvious. The saving in the cost of straw, the labour of thatching, and the damage often arising from heavy and continuous rain coming when a stack is only half built, combine to make such buildings very desirable. Hay may also be carried a little sooner to a hay barn or loft than to a stack, the pillars or sides preventing the hay from sinking so much. Hay barns when partially emptied may also often be very useful for sheltering stock or implements. It is to the interest of most tenants of farms where much hay is got to pay a percentage upon the erection of such buildings. Hay should never be carried to stack or barn when there is any wet in it, as it is certain to go mouldy, and be very poor fodder. It should also be sufficiently made to avoid overheating. It is better that a stack should sweat a little and go solid, but if this goes too far the hay will be damaged, and there is great risk of combustion. A long, round iron bar, with a slight hook at the end, will enable the state of the centre of the stack to be ascertained, and if it be found very hot, and the hay almost black, no time should be lost in cutting down to the hottest place. The plan of making very wide stacks causes overheating, unless hay is thoroughly made.

Within the last few years various methods have been suggested or devised for artificial haymaking. Mr. W. A. Gibbs, of Gilwell Park, Chingford, Essex, has patented contrivances for driving hot air among the half made hay, thrown continuously into a long trough, and there subjected to a tossing by revolving forks in the midst of the hot air,

which carries off its moisture, as it passes from one end to the other, ultimately leaving the trough at the farther end in a condition fit for the rick.

A simpler and even more ingenious suggestion was also adopted in various parts of the country, but has not come into general use. By this method the first heating arising in a rick of insufficiently made hay is itself made the agency of the subsequent drying and safe curing of the stack. This is managed by simply providing a horizontal shaft, either under the ground on which the rick is built, or, by means of suitable boarding, within the lower layer of the rick itself, and connecting with it one or more upright shafts into the body of the rick. A fan is used, fed from this arrangement of shafts at its outer end, and the rapid revolution of this fan is found to draw air through the whole body of the hay in rick with sufficient rapidity at once to keep the temperature within safe limits, and by means of it to carry off the moisture still remaining in the hay.

We have ascertained, in the case of clover, that a single dry day, though without sunshine, suffices to remove quite half the moisture in the fresh cut produce, while it takes two additional days to remove so much of the remaining moisture as must be taken out before the clover is fit to stack. This is no doubt true of the grasses also, so that it is the risk attending the later stages of the process of haymaking which is the most serious. And a contrivance enabling us to put grass in rick after only one day's exposure to dry air and wind, finishing the process of haymaking in the rick itself, would be most welcome. The principal condition of success is that the half-dried grass shall have been well

shaken out, which, indeed, is a condition of all good hay-making; and that there shall be no clung locks of grass remaining as when laid on the land by the mower. The system of ensilage has been successfully carried out in many cases. A description of this process will be found in chapter ix.

A chapter on laying down land to grass, including some further reference to the separate grasses whose seeds are selected for the purpose, will be given further on, as belonging to the general subject of the crop management of arable land, to which we now direct attention: beginning with a chapter on the subject of crop rotations.

CHAPTER II.

ON ROTATIONS OF CROPS.

HISTORY.—**Theory.**—**Influence of circumstances.**—**Continuous corn cropping.**—**Norfolk rotation and modifications of it.**—**Berwickshire rotation and modifications of it.**—**Six-year, seven-year, and eight-year rotations.**—**Catch cropping.**—**Restrictive clauses of leases.**

IN the early husbandry of this and other countries, the practice was to take as many crops of corn, varied occasionally with one of pulse, as could be grown in succession; after which the land got a year's bare fallow, or was left a number of years under grass. The arable land was divided into two parts; one-third or one-fourth "infield" and the remainder "outfield;" the proportion of the former being determined by its proximity to the farm-yard, and the amount of dung produced there. The infield was arranged in three divisions, each of which was cropped successively with (1) wheat or barley; (2) oats or barley; (3) beans or peas: and all the dung made on the farm was bestowed on one or other of these divisions. The outfield was also subdivided; either into two parts, with one-half corn, and one-half grass two years in succession; or into three parts, with each third three years under corn, then six years under grass.

As in those days no grass-seeds were sown, and few stock kept and little dung produced, the practice may be

described as corn growing to exhaustion, then leaving the land to nature, or, where more labour was employed, as in the wheat districts, giving it a year's fallow.

No material change took place in this wretched husbandry until the turnip and clover crops came into field cultivation. The idea of a restorative system of cropping was, however, clearly foreshadowed in the two years' course of (1) wheat, (2) beans. This system enabled the bare fallow to be dispensed with on lands of good quality, but it produced little manure, and it was only suitable to clay soils or clay loams, which in wet seasons could not be thoroughly cleaned in time for winter sowing. The great transformation was worked by the introduction of clover and turnips. These crops did more than fulfil the cleansing and ameliorating purposes of the bare fallow; they provided abundance of winter food for live stock; thus making not only more meat, but more manure, which also meant more corn.

The effect of the introduction of chemical manures was equally marked; though here the operation was different. The use of these fertilizers makes it easy to recompense the soil for any loss through cropping, and even to grow the same crop on the same land many years in succession, if circumstances render it convenient or advantageous to do so. As has been shown, nothing but a scarcity of manure prevented continuous corn growing becoming general in the early days of crop husbandry. Even then, however, it was practised with success on the infield; and in later times there have been many notable examples of it. Thus, Mr. Lawes of Rothamstead has elaborately illustrated the possibility of continuous corn growing; and Mr. Prout of Sawbridgeworth, with a plentiful command of artificially compounded manures, has carried it out, hitherto with

profit, on a large scale, and without injury to the land, especially on the heavier class of soils.

A rotation of crops is no longer a necessity for the maintenance of fertility. Fertility of soil can be maintained, and even increased, if only the special ingredients carried off in the crops are restored by an equivalent of manure. Provided, indeed, the one condition of restoration be fulfilled, it matters not what or how much the land is made to produce. It may be farmed on a system of continuous corn, hay, potato, sugar, or tobacco growing; or it may be under any variety of crops, grown in any order of succession; the principle holds good throughout. The general practice of market gardening illustrates this truth more forcibly perhaps than a few exceptional cases of continuous corn growing. The market gardener has no fixed rules as to cropping. He dresses his land annually with 30 or 40 tons of dung per acre, or a good substitute for it, and he grows such crops as come early to maturity, and makes them succeed one another rapidly.

But although a rotation of crops is not indispensable to good husbandry, there are many reasons why rotations should be practised at times. (1) A judicious rotation is economical of manure, because different crops take different ingredients from the soil, and a proper succession of crops will therefore gradually bring all the elements of plant food existing in the soil into use, instead of rapidly exhausting some and leaving others in a measure untouched. (2) All plants are not able to make equal use of the food contained in the soil, this depending on (*a*) the extent to which the roots ramify in the soil, (*b*) the length of time during which the plant grows, and (*c*) the specific power of absorption possessed by the roots. (3) A rotation of crops enables

the labour of the farm to be carried on in proper sequence and to be evenly distributed over the various seasons. As a given staff of men and horses have to be maintained all the year, the proper distribution of their labour becomes important, and this cannot be secured where all the land is under the same crop. (4) A regular alternation of crops is favourable to the thorough cleansing of the land, and therefore the crops turn out to be more productive and worked at less expense. (5) Some crops draw their substance more largely than others from the air; some, again, more deeply from the subsoil; and in each case the surface soil becomes enriched for the benefit of a succeeding crop, which may especially need the contribution to fertility which is thus made. (6) By an interchange of crops the produce of some will be more healthy and vigorous. Clover and turnips, for example, cannot be profitably reproduced on some soils, except at considerable intervals of time. Change of crops, also to a great extent prevents the increase of predatory grub, and insects. By repeating a crop which had the previous year encouraged their development, many insects injurious to farm crops will multiply exceedingly; whereas by interposing a crop on which the larvæ of any particular species cannot live, the whole of that race must perish. (7) Where live stock is kept a mixture of straw and green crops must be grown to supply food and litter.

A perfect rotation should include all those crops which the soil, climate, and situation of the farm will admit of being cultivated at a profit. The conditions which influence the species of crops grown are, (a) the nature of the soil, (b) the character of the climate, (c) the kinds of live stock kept, and systems of management, (d) the demand for certain crops, and the convenience for

marketing them. Thus, in regard to soils, clays are specially fitted to produce crops of wheat, beans, mangels and cabbages; light soils are favourable to the growth of barley, turnips, peas and clover; and peaty soils may yield excellent crops of carrots, rape, and oats, &c.—The conditions of climate have great influence on the cropping. The dry climate of the south and south-east is more favourable to the cultivation of wheat, barley, and leguminous plants, than to the development of root or green crops. In the moist climate of the West of England and Ireland, the humidity of the summer is unfavourable to the growth of wheat, barley, peas, and beans, but favourable to turnips, rape, grass, and oats; while the mild winter is favourable for growing early spring food, and market produce, such as winter tares, rye, early potatoes, &c. In a mountain climate the comparative shortness of the summer season is more prejudicial to corn crops than to roots and grass. On the humid elevations of the West of England, Scotland, and Ireland, oats are the most suitable grain crop; whilst on the dry soils of the South of England, barley is more appropriate.—Again, as to kinds of live stock, and management. Cattle require a greater breadth of straw and forage crops than of root crops to be eaten on the ground; sheep the reverse. Dairy stock require more of succulent green food than they do of dry fodder; fattening animals the reverse.

The best proportion in which to grow the different crops will be regulated by (a), the labour required in their cultivation, (b) the market values of the different crops, and (c) the number of live stock to be provided for. The labour of cultivating the different crops very much determines their prime cost to the cultivator; and

as a certain labour-force, animal and manual, has to be maintained on the farm, it is important that the work to be done by it be so distributed as to fill up the year. The number of men and horses required will mainly depend on the extent of the fallow crop, which it is therefore desirable to keep as near to an average breadth as possible.

The best order or succession in which to grow the different crops will depend on (*a*) the special food requirements of the plants, (*b*) the ability of any particular crop to make use of the food for it contained in the soil, (*c*) the ameliorating effect of the crop, (*d*) the opportunity it affords for cleaning the land. The necessity for a rotation is sometimes attributed to different crops removing different kinds or quantities of food ingredients from the soil. Thus, some crops require for their growth a larger expenditure of nitrogen than others; some take up relatively much phosphoric acid, others take up relatively much potash and lime; and this rotation theory is that each individual crop is grown at the least cost and to the best advantage when it is made to follow one having different food requirements. There is, however, much less difference in the exhausting effects of different crops than is generally imagined. In every case where a crop is grown, no matter whether there is continuous cropping of the same plant, or a rotation of crops, the soil is poorer if that crop or any portion of it is carried away: and the reason why some crops exhaust the soil more than others is thus not altogether due to variations in the food requirements of the different crops, nor to the extent to which each of them can avail itself of the plant food in the soil, but rather to the use that is subsequently made of this produce. The most exhausting crops are those grown for their seeds, which

are sold off the farm ; whereas the ameliorating crops, as they are termed, are usually consumed in the green state, and in many cases fed on the land. Still, much depends on the capacity of the plants for obtaining food from various sources, and assimilating it in different forms. A crop of wheat, for example, collects only about 45 lbs. of nitrogen per acre, while a crop of clover contains nearly three times that amount of nitrogen ; and yet the wheat exhausts the land of nitrogen and the clover enriches it. This is explained by the fact that the cereal crop contains in its seeds a large amount of non-nitrogenous compounds, the deposit of which has required the passage through their system of much nitrogen, and this, together with the mineral matter carried off by the crop, produces exhaustion of the soil. On the other hand, clover derives but a small part of its organized structure from the soil, while by its large system of leaves it absorbs a considerable quantity of nourishment from the atmosphere, and probably by shading the ground retains evaporable nutritive substances in the soil. Leguminous crops in general, also the grasses and the broad-leaved root crops, are, for similar reasons, less exhausting than the cereals.

The practical relations of the rotation to the work of keeping the land clean remain to be named. The opportunity for cleaning the land will depend on the interval of time between harvesting one crop and planting or seeding another, and also on some crops admitting of drill cultivation and thus of being hoed during their growth.

These varied conditions are generally met by cultivating grain and green crops in alternation. In the two-years' course, already mentioned, wheat and beans were grown alternately on certain soils. The American rotation of

(1) Wheat, (2) Clover, is an improvement in many respects. It is more ameliorating, it gives cleaner land, and is worked at less expense. On good soils free from clover sickness this rotation would probably yield more profit than any other; but although it succeeds to admiration on the fresh prairie lands, there is no land in this country that will grow clover every second year.

The two-years' course being condemned as too short, led to a three-years' rotation. On good lands it was (1) Wheat, (2) Clover, (3) Potatoes, cabbages, turnips, &c.; on inferior soils, oats and barley took the place of wheat. This rotation was favourable for cleaning the land, and yielded a large quantity of manure; but the proportion of fallow crop was too great for economy in working; and the clover would not bear such frequent repetition.

In some districts the three-years' course was (1) Wheat, (2) Turnips, (3) Spring corn. This was the opposite extreme, as it gave too large a proportion under grain crop; and being found too exhausting on light soils, clover was introduced between the spring corn and the wheat, the result being the Norfolk 4-course—

1. Wheat.
2. Turnips.
3. Barley or oats.
4. Clover.

In this rotation the grain and green crop alternate in equal proportions, and of the green crops one is a fallow and therefore a cleaning crop, and both are also ameliorating crops. The succession of the crops in this course is also such that the whole of the manure is made use of; those parts of it which are not fitted for one crop, furnishing nourishment for another. This rotation is practised,

more or less, in every county, and is not confined to light soils only ; wheat and mangels on the heavier soils taking the place of barley and turnips.

The frequent recurrence of both clover and turnips is an objection to the Norfolk course, if followed without modification on soils at all liable to clover or turnip sickness. But the great value of this rotation is that it admits of endless variation in the cropping, without departing from its main features. Thus, instead of taking turnips every fourth year, interchanges may be made of swedes, mangel, cabbages, kohl-rabi, carrots, potatoes, &c. ; and instead of clover every fourth year, a crop of beans, peas, vetches may be taken, thus bringing in turnips or clover at intervals of 8, 12, 16, &c. years, instead of every fourth year.

On the thin chalk soils near Salisbury, Mr. Rawlence adopts the following modifications of the 4-course.

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| (1) Wheat. | (2) Barley. | { (3) Clover, mown. (4) Clover, fed.
Or,
(3) Swedes, after Italian rye-grass :
and (4) Mangels, or cabbage. |
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By following wheat with barley a better sample of the latter is obtained ; and by leaving the land two years in clover, as also by following swedes with mangels, the expenses of cultivation are considerably reduced.

Another gentleman, on light land near Evesham, takes

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| (1) Wheat. | |
| (2) Winter Beans, followed by rape and turnips. | (2) Early peas, followed by rape and turnips. |
| (3) Wheat, followed by vetches and winter oats. | (3) Barley, followed by rape and turnips. |
| (4) Swedes. | (4) Mangels. |

Here wheat is made to follow winter beans, swedes, or mangolds. An important feature in these modifications

of the Norfolk rotation is seen in the catch crops which are taken two years out of four. Three-fourths of the land are under root and green crop every year, and still three-fourths are under grain and straw crops.

The Berwickshire 5-course is a simple extension of the Norfolk 4-course; the clover and grass seeds being left down two years in this case instead of only one as in the Norfolk rotation. Thus—

1. Wheat or oats.
2. Roots.
3. Barley or oats.
4. Clover and grass seeds.
5. Clover and grass seeds.

This rotation has long been a popular one throughout the north of England and the whole of Scotland. Nor can there be any doubt that where land can be allowed to lie more than one year under "seeds," it conduces much to economical management. But this point is chiefly regulated by climate. In the warm and dry climate of the south and south-east, for example, clover, from being a deeper-rooted plant, can maintain its growth better than the grasses; whereas in the cooler and moister atmosphere of the north and north-west, the grasses flourish greatly, and by their thickly-matting roots tend to exclude the clovers. The influence of climate thus has a most important practical bearing in the settlement of rotations of cropping. In the moist climate of the north, the grasses spread over the surface of the land and keep weeds in check, so that grass can be left down two or more years with every advantage; but in the drier and warmer south, it is very different. There the seeds sown are principally clovers, which deteriorate after the first year, and become

partly supplanted by weeds, so that when the two years' growth is broken up for wheat, the land is never so clean as after one year only.

Among other variations of the five-years' course, the following are worth notice:—

	No. 1.	No. 2.	No. 3.	No. 4.
1st year . . .	Wheat.	Wheat.	Wheat.	Potatoes.
2nd year . . .	Root and Green Crop.	Barley.	Barley.*	Wheat.
3rd year . . .	Wheat.	Sainfoin.	Turnips.	Barley.
4th year . . .	Barley.	Sainfoin.	Barley.	Seeds.
5th year . . .	Seeds.	Sainfoin.	Seeds.	Seeds.

No. 1 is, or was recently, practised by Mr. C. Howard on his farm at Biddenham, Beds.—the soil a mixed loam. It is the Norfolk course extended by the introduction of a second wheat crop before the barley, a practice which, on land full of manure, will improve the barley, while at the same time the clover is thus less frequently repeated. In this rotation, wheat, however, and not barley, is the chief crop.

No. 2 is a course of cropping followed to some extent by Mr. Rawlence, near Salisbury, on a thin chalk soil. Here also barley follows wheat; but the most notable thing about this rotation is the absence of a root or fallow crop. This system can be worked at little expense, as three-fifths of the land is under sainfoin, and the remaining two-fifths under corn; but as it affords no opportunity for giving a thorough cleaning to the land, it is not likely to be long maintained in practice.

No. 3 is a rotation which was adopted at one time by the late Mr. Hudson, at Castle Acre, Norfolk, on a mixed soil of clay, chalk, and gravel. Barley in this case is the

* Followed by rye, vetches, or even early peas.

chief crop, as it is grown twice in five years—once after wheat and once after roots. A catch crop is also taken between the barley and the root crop.

No. 4 is practised to some extent in South Lancashire,* where all the crops are sold off the farm, for the supply of Liverpool, and manure bought. The only difference between this and the Berwickshire 5-course is that in the former barley follows wheat, and potatoes are grown instead of roots.

The six-year rotations now practised may be divided into three classes :—

1st, Those with the land three years under grass seeds. This may be an extension of the Berwickshire 5-course,—

1. Wheat or oats.
2. Roots.
3. Barley or oats.
4. Seeds.
5. Seeds.
6. Seeds.

or roots may be taken after seeds, and barley made to follow oats. Owing to the increasing cost of labour and tillage, many farmers are now working on one or other of these crop rotations. Three years under grass seeds is common all over the north and north-west, and it is partially adopted in other districts. It appears, for example, on one of the prize (Large Dairy) farms in the Derby district, 1881 ; and it is met with now and again in districts south of London. By this system, half the land is under clover or grass, one-third under corn, and one-sixth under root crop.

* Professor Wilson

2nd, Rotations with the land two years under seeds.

	No. 1.	No. 2.	No. 3.
1st year . .	Oats.	Potatoes.	Potatoes.
2nd year . .	Wheat.	Wheat.	Wheat.
3rd year . .	Roots.	Potatoes.	Turnips.
4th year . .	Barley.	Wheat.	Barley.
5th year . .	Seeds.	Seeds.	Seeds.
6th year . .	Seeds.	Seeds.	Seeds.

No. 1 is the rotation practised on the 2nd prize (Large Dairy) farm in the Derby district, 1881 ; it was also observed on the 2nd prize farm, Wolverhampton district, 1871. In all probability the land would not be clean enough to take wheat after two years' clover ; otherwise, wheat, barley, roots, oats, clover, clover would be preferable. The following might, however, be taken—oats, roots, wheat, barley, clover, clover ; but the seeds in all probability would not follow two-grain crops so well without the interposition of a root crop.

No. 2 is a peculiar course of cropping which is followed to some extent in the alluvial districts near the mouth of the Humber.

No. 3 extends the Berwickshire 5-course by interposing a crop of potatoes between seeds and wheat, and is met with in the Lothians and other districts.

3rd. Rotations with the land one year under seeds.

	No. 1.	No. 2.	No. 3.	No. 4.
1st year .	Oats.	Wheat.	Wheat.	Oats.
2nd year .	Beans or Potatoes.	Beans.	Roots.	Turnips.
3rd year .	Wheat.	Wheat.	Wheat.	Wheat.
4th year .	Roots.	Roots.	Beans.	Beans.
5th year .	Wheat or Barley.	Barley.	Barley.	Wheat.
6th year .	Seeds.	Seeds.	Seeds.	Seeds.

The first of these is known as the East Lothian 6-course.

It is to all intents the Norfolk 4-course, preceded by oats and beans or potatoes. Wheat after potatoes would not succeed in a dry soil and climate, but it answers well in a moist climate. Mr. Treadwell, however, on a stiff loam near Aylesbury, Bucks, finds the East Lothian rotation, with catch crops, perfectly satisfactory. No. 2 is almost similar, and is followed on the 2nd prize arable farm, in the Derby district, 1881; also in the neighbourhoods of Banbury, Romford, &c., all on strong land. No. 3, Mr. Paine's, is an example from Bedfordshire—soil, a strong clay. No. 4 is an example from Ayrshire.

Many of the seven-year rotations met with are merely extensions of the 4- or 5-year courses, obtained by keeping the land 3 or 4 years under "seeds;" a practice which has been gaining ground lately for economical reasons, wherever the conditions are favourable for such an extension of pasturage. In the wheat and potato districts around Dunbar, and also in Forfar, Kincardine, and other parts, the East Lothian 6-course has been extended, as follows:—

1. Oats or Potatoes; 2. Potatoes or Beans; 3. Wheat;
4. Turnips; 5. Barley or Oats; 6. Seeds; 7. Seeds.

Some farmers in the same districts are taking, 1. Oats; 2. Potatoes; 3. Turnips; 4. Barley; followed by 3 years clover and grass.

The following are examples from Wiltshire:—

ON STRONG LAND.

1. Wheat.
2. Beans.
3. Wheat.
4. Vetches and Mangel.
5. Wheat.
6. Clover (twice cut).
7. Clover (once cut, then fed).

ON LIGHT LAND.

1. Wheat.
2. Swedes and Turnips.
3. Barley.
4. Peas.
5. Wheat and oats.
6. Clover (twice cut).
7. Clover (once cut, then fed).

On the Yorkshire wolds a common rotation is :—

1. Wheat ; 2. Roots ; 3. Barley ; 4. Peas ; 5. Roots ; 6. Oats ; 7. Seeds ;

or on deep soils, where the wheat plant does not stand well after seeds, the relative positions of wheat and oats in the rotation are reversed ; the wheat in such cases following turnips or rape, after which it succeeds well.

This long list of examples may be closed by two more illustrative of eight-year rotations.

No. 1.	No. 2.
1. Oats.	1. Wheat.
2. Wheat.	2. Turnips.
3. Beans or green crop.	3. Oats.
4. Wheat.	4. Potatoes.
5. Roots.	5. Wheat.
6. Barley.	6. Seeds.
7. Clover.	7. Oats.
8. Clover.	8. Potatoes.

No. 1, which is virtually an extension of the Berwickshire 5-course, was found in practice on the 1st prize mixed or arable farm, Derby, 1881, the soil a strong, red loam. No. 2 is a rotation met with in the neighbourhood of Dundee.

Where the climate is fine, and the harvest early, a catch crop after the regular crop of grain has been reaped is quite possible, and will be found beneficial, especially on light and medium soils. Catch crops can be got after all grain crops, where the land has not been sown with clover or grass seeds, and where a spring crop is to follow ; but especially where roots with their later seed-time follow corn in the regular course. In the Norfolk course, for example, a catch crop can be got after wheat ; and in the

East Lothian course, after oats and after wheat. Except in late climates, both oats and wheat are commonly off the ground by the middle of August, and if the land be immediately prepared and sown with white mustard, it will be up and ready to cut about the middle of October. There will still be time enough after that for another crop, such as early peas, sown in November, to come off in June or July, in time for late turnip seed-time. Rape sown in August or September will be ready to feed in November. Stubble turnips sown the end of August will be ready the end of November or beginning of December. Winter rye, vetches, and trifolium incarnatum, also, if sown in September or October, will be up and ready to cut in April or May and leave the land free for a root crop. Italian rye grass sown in August or September will be ready to cut or fold in April. Cabbages planted out in October will be ready the middle of June or July. Drumhead cabbages planted out in June or July will be ready in December and January.

Catch cropping, however, is not so suitable for late climates, as in such districts it is apt to interfere with the regular course of management. But even in the North, there are many small crops which may be interposed with advantage.

The farmer should imitate the practice of the market gardener in this respect, and take as many successive crops as possible on the same ground within the year, for which he has but one rent to pay. For instance, early peas may be sown in February and picked in June, in time enough to take a crop of turnips, and these again could be got off in time for winter cabbage or some faster growing crop. Early cabbage can be followed by turnips,

and these again by coleworts. Early potatoes, carrots, or onions can be got off in July in time to plant the land with cabbages or coleworts; and as the latter only occupy the ground three months a second crop of them can sometimes be taken. The important thing is to plant such crops as are not long in coming to maturity, and to make them succeed one another without intermission.

Far more importance, it will be seen, is to be attached to the study of those general principles which should regulate the succession of crops, than to the laying down of stereotyped rotations. The practice of cropping must vary, not only in different districts, but even on the same farm at times to suit changing circumstances. Land cannot be farmed to its full profit when the practice of the cultivator is limited by strict rule. Some leases not only stipulate that the tenant shall not take certain crops except at stated intervals, but even limit the extent to which certain crops shall be grown. The restrictive clauses may be :—

1. That two or more grain crops shall never be taken in immediate succession.
2. That no hay, straw, or roots, shall be sold off the farm.
3. That only a certain acreage of potatoes, &c., shall be grown.
4. That land shall be two or more years in grass.

It has been justly observed that all such restrictions were originally imposed on the supposition that the farm was to maintain its own fertility. They did not contemplate the purchase of large quantities of manure and feeding stuffs, which is now general. Mr. Lawes has recently illustrated before a Royal Commission on Agriculture, the loss that may be entailed on a tenant by restrictions in the growth and sale of crops. The chemical value of a ton

of white straw is 12s. 6d. This ton of straw can frequently be sold for 50s. or more ; and yet the tenant can purchase its equivalent in manure for a third of that sum ; but in few cases is he allowed to do so. Under proper regulations, as to purchased fertilizers, there can be no harm in allowing a tenant to grow what crops he deems best, and to sell hay, straw, and roots, &c., off the farm.

The varying capability of the several crop-rotations, as regards their provision of food for live stock might have been illustrated here. This, however, will be found discussed in another hand-book. The quantity of live stock which can be maintained upon a farm, under any of the several rotations which have been enumerated, and the provision of farm-yard or fold manure, which is thus possible under each, will be more properly considered in pages describing the management and fertility of the soil.

CHAPTER III.

OUR GRAIN CROPS.

Wheat.—Barley.—Oats.—Rye.—Beans.—Pease.

THE list of our grain crops we take from the Annual Returns of the Acreage of each issued by the Board of Agriculture.

The following were the figures, giving the area of each crop in the harvest of 1891.

Crops.	England.	Wales.	Scotland.	Great Britain.	Ireland.	United Kingdom, including islands.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Wheat . . .	2,192,393	61,590	53,294	2,307,277	81,394	2,392,245
Barley . . .	1,772,432	117,101	223,265	2,112,798	178,299	2,298,978
Oats . . .	1,672,835	234,055	992,239	2,899,129	1,214,475	4,128,127
Rye . . .	38,081	1,086	7,473	46,640	13,430	60,148
Beans . . .	337,493	1,884	15,325	354,702	4,142	359,039
Pease . . .	201,648	1,533	1,096	204,277	589	204,972
Total of Corn Crops }	6,214,882	417,249	1,292,692	7,924,823	1,492,329	9,443,509

We propose to describe them in the order in which they are here enumerated.

Wheat* is the most important and most valuable of our grain crops, occupying in England nearly as much area as

* *Triticum vulgare*. Common wheat. Natural order.—GRAMINACEÆ.

oats and barley together. The main varieties of wheat are the red and white, the bearded and beardless, and the winter and spring wheats. The colour of wheat is influenced in some measure by both soil and climate. Winter and spring wheats are not specifically distinct. They can be converted, either into the other, by repeated sowing, earlier or later, thus gradually accelerating or retarding their growth. Red wheats are hardier and more easily grown than white, and they are heavier croppers; but the most prolific varieties are not, as a rule, the best in quality, nor of the greatest value to the miller.

The soil best adapted to the growth of wheat is a deep loam inclined to clay, with a dry subsoil—heavy land, more or less compact. Practically, however, nearly every kind of land, whether clay, loam, chalk, gravel, or sand, will produce fair crops of wheat if in good condition, unless where the climate is really unfavourable for the purpose. The southern, south-eastern, and midland counties of England are the best districts for wheat. Comparatively little wheat is grown in the three northern counties of Cumberland, Westmoreland, and Northumberland. It is not the rainfall so much as the temperature that appears to govern the extent and prevalence of wheat-growing, for in some of the wetter districts capital wheat is produced. Wheat, as is well known, is more sensitive of temperature than any of the other cereals; and we find that in Wales, with its higher temperature though moister climate, one-fifth more wheat is grown than in all Scotland, although the latter is four times its extent. Latitude, altitude, and exposure mainly regulate temperature.

A summer fallow is now less frequently resorted to as a preparation for wheat than formerly, and wheat generally

occupies a place in the rotation following clover, roots, beans, or vetches. A fine tilth, which is so desirable for spring corn, is not specially required for autumn sown wheat, nor is a very dry seed-bed approved of. The time of sowing is very much a matter of local experience, and is more or less regulated by the weather and the fitness of the ground. October and November are the common seed-time. Bare fallows are, as a rule, seeded earlier. Light land is seldom too wet for sowing winter wheat, but when a good tilth is obtained on heavy soils it is better to sow than run the risk of wet weather setting in that might delay the work unduly. August and September sowings have been recommended in some late districts, but these periods do not comport with ordinary English agriculture.

The quantity of seed to be sown on the acre is very various and has given rise to much controversy. That quantity is best which yields the largest crop, and the solution of that point rests on the experience of the individual grower. The answer depends on many considerations; the quality and condition of the land, the climate, the goodness of the seed, the time of sowing, and the mode of sowing. One bushel per acre may suffice where the conditions are all favourable; 6 pecks are a common seeding: and even 3 bushels may not be found too much under other circumstances. Whatever be the quantity, it is desirable that the ground be fairly occupied by plants when the spring and early summer growth commences. It is not now common to seed the land so thickly as was done formerly, when broadcast sowing was common; but our forefathers were not fools, and if the corn plants had not stood close together in the days of weeds and wet land, the weeds would have over-mastered the corn.

In cold and elevated districts what is called "thin seeding" is never practised, and, as a rule, the most seed is sown on the poorer soils, as the plants on such land do not tiller, and therefore a greater number of roots are wanted. This has been controverted by ingenious persons, who inquire, if ten plants require one foot of land to perfect their growth, what effect may be expected but starvation if 20 plants are grown on the same space? Experience, however, outweighs theoretical considerations. The plant when small and weak occupies less space, and in consequence more stems or stalks are then required for mutual shelter and support; and without a considerable number of straws the crop may break down before reaping time.

Corn is sown by drill, by broadcasting with hand or machine, and by dibbling. Two bushels per acre broadcast is not in its result a thicker seeding than $1\frac{1}{2}$ bushels if drilled, or 1 bushel if dibbled. Broadcasting is the cheapest and most expeditious method of sowing; but the sowing of grain in rows by the drill has three main advantages over broadcasting, viz., the saving of seed, the ability to hoe the spaces between the rows in spring, and the deposit of the seed at equal and uniform depth in the soil. Eight to ten inches are the common distances between row and row. When of less width the intervals cannot be well hand or horse-hoed. Where there are no weeds to keep down, and where a baked surface only requires stirring and breaking, that can be done expeditiously and economically by the common harrow, and broadcasting may be perfectly satisfactory. Wheat stands, and even improves, under a considerable amount of rough handling in spring; and where the land is clean it is much the same whether it be sown broadcast or drilled.

Whatever be the distance between row and row, the narrowness of the rut into which the seed drops from the drill is a considerable defect connected with the practice of drilling. It is found that many of the stems are thus dwarfed by crowding, which proportionately reduces their strength and thickness, and the size of the ear and kernel. To obviate this fault a modification of the row culture is had recourse to by some farmers, viz., ribbing, or furrow-pressing the land, and then sowing broadcast over the surface. It is then harrowed, and the plants come up in rows in a less dense form. By dibbling, the seed is deposited in holes made at regular intervals a few inches apart, and two to three pecks of wheat suffice for an acre of land in good heart; but no drop drills or dibbling machines, ingenious as some of them are, have obtained general acceptance, and drills of various constructions that discharge a continuous stream of seed are the machines in common use in England. Dibbling, or dropping, is certainly a more perfect mode of sowing than any of the other methods; but hand dibbling consumes too much time and labour, and it is not practicable to carry it out on a large scale, and on all kinds of soil.

The best returns are of course only attainable when there is a practical approach to giving every plant a clear space of ground to grow upon. When each plant is in the centre of its own square, it has room to expand and draw nourishment from the soil and the air with greater facility. In properly ploughed land, pretty well pulverised, broadcasting gives a fairly equal distribution of the seed, only somewhat irregular in depth.

The quality of the seed is another consideration in sowing; for choice corn, if a change has been got from a

different soil and climate, will produce plenty of plants with one-third or one-fourth less seed than in other circumstances. Every good farmer prefers bright, sound, plump, and well-cleaned seed, and certain strains have hereditary qualities which it is well to respect.

Among the leading varieties are the following :—

Name.	Colour of grain.	Character of straw.	Colour of chaff.	Suitable.
Browick . .	Red	Stiff	Red	Everywhere — but needing renewal.
Golden Drop . .	Red	Medium	Red	On good soils.
Hardcastle . .	White	Strong	White	Common—Southern Counties.
Rough Chaff or Essex White .	White	Stiff	White, woolly	Essex, Midland Counties.
Talavera . .	White	Tall	White	On rich sandy soils.
Chidham . .	White	Medium	White	On warm chalk.
Rivetts . .	Yellowish	Coarse	Awned	On poor soils—a free grower.
Red Chaff White	White or yellow	Stiff	Red	
Hunter's White	White	Slender	White	Originating in East Lothian.
Square-headed .	Yellow	Stiff	White	A recent introduction.
Nursery . .	Red	Fine	White	South of England.

In calculating the increase of a corn crop from the quantity of seed sown, we meet with anomalies which show that such calculations are of little practical importance. Assuming that two bushels of wheat are sown on an acre of ground (which is a not uncommon quantity), if we take thirty bushels as the average return we only get the average number of grains in the ear to be fifteen, which looks exceedingly little. This estimate is based on the assumption that each seed produces only

one stem ; but on land of a fertile description two or three shoots from one root is not an excessive calculation. When there are two ears from every seed, with thirty-two corns on each ear of wheat, and the land is sown at the rate of $1\frac{1}{4}$ bushels an acre, the increase, according to the arithmetician, ought to be sixty-four-fold, or at the rate of eighty bushels an acre. The data on which these calculations are based seem sufficiently moderate ; but such large crops are really never reaped in this country, and it is difficult to account for the great difference between the computed yield and the actual returns. No ordinary loss of plants, number of dead seeds, seeds buried too deep, or seeds left uncovered, will explain it. There are, however, sundry other sources of loss, such as ears that fructify imperfectly, and strong plants starving and smothering slight ones, as in an overcrowded plantation ; and often the most extensive loss of plant is by slugs and insects.

The number of seed-corns of wheat, barley, and oats sown on the square foot in ordinary field practice differs considerably. The quantity of barley planted is about one-third more than wheat, and the number of kernels of oats is more than double that of wheat. It is fully twenty years since tables were published of the number of seeds in a pound weight of our commonly cultivated crops, from which the number usually sown may be calculated. The samples then were partly supplied by the late Mr. Rendle, of Plymouth. They were as follows, and, for the sake of comparison, some determinations recently made from samples received from Scotland and various parts of England are also entered, the averages of each kind of corn being given :

Grain sown.	No. of seeds per lb.	Quantity sown per acre.	Corns on each square foot.
		bush.	
Wheat (Rendle) . . .	10,500	1½	22
Ditto (Bowick) . . .	10,100	1½	21
Barley (Rendle) . . .	15,400	3	56
Ditto (Bowick) . . .	9,320	3	34
Oats (Rendle) . . .	20,000	4	71
Ditto (Bowick) . . .	15,900	4	59

The two entries of wheat are almost identical, but there are great discrepancies in the two samples of barley and oats respectively, and the results of course differ widely; the size of grain in wheat, barley, and oats varying considerably in different sorts. The wheat was estimated at sixty-two lb. per bushel, a weight at which it is sold in many parts of England. The barley as supplied from Plymouth was computed at fifty-three lb. per bushel; the sample with which it was compared was fifty-six lb. per bushel. A pound of fine barley contained 9,800 kernels, and being sown at the rate of three bushels an acre, there were thirty-seven corns to the square foot. The oats of our experiment ranged from a Poland oat of forty-six lb. per bushel to the "Tam Finlay" oat, a favourite variety in Ayrshire, which weighed only 36 lb. per bushel.

Assuming our computations to be correct, and that the seed corns were equally distributed over the whole surface of the ground, each kernel of wheat would have more than six square inches to grow in, each seed of barley would have a space of $4\frac{1}{4}$ inches, and each oat seed would have nearly $2\frac{1}{2}$ inches. Where drilling or row culture is practised, the case is considerably different. If the rows were 9 inches apart from centre to centre the square foot would be 16 inches long of such a row. And if the rows were

2 inches in breadth, the plants would just occupy 32 of the 144 inches in the square foot, and thus each seed of wheat would have $1\frac{1}{2}$ inch, of barley nearly 1 inch, and there would be nearly two oat seeds in the square inch, calculations which, trifling as they may be deemed by some, throw some light on the subject of sowing.

When wheat is taken after clover, the sward is ploughed under in August or September, a skim coulter being used to turn every green leaf under; and, being left for a month or more, the land is then harrowed down, and the wheat drilled $1\frac{1}{2}$ bushels per acre on a stale furrow; or the drill presser is used to harden and deepen the plough furrows, and the seed, nearly 2 bushels per acre, is sown broadcast and well covered by harrowing.

After root crops, as mangels or swedes, the crop is removed, the leaves are left to wither or eaten off by sheep, and the preparation for wheat sowing consists in either a shallow ploughing or a mere scarifying; the seed being covered by the harrows, and the furrows between the land being afterwards well cleaned out by the plough and spade so as to leave free passage for surface-water in wet weather during winter.

Wheat is liable to the attacks of many destructive enemies. Its straw may become mildewed or rusted before it has finished its work of feeding the ear; and an abundant promise may thus be disappointed at harvest time. Its grain becomes "bunted," swelled, and full of black powder at harvest time, or black and hard as peppercorns, and found on examination to be full of eel-like animalcules. And it is also the victim of wireworm in the earlier stages of its growth, and of the grub of the wheatfly at harvest time. Mildew is the result of the attack of a parasitic

fungus, which is less liable to attack an early than a late crop. A moist July is thus to be dreaded. Bunt is also the result of a fungus attack ; the germs, left on the surface of the grain from a previous harvest, entering the plant by its roots; it is believed, and ultimately reaching the ripening seed. To avoid it, the grain of wheat is invariably subjected to a cleansing process before being sown. The simplest cleaning, and one which is perfectly efficient, is effected by throwing a gallon of water, in which half-a-pound of sulphate of copper (blue vitriol) has been dissolved, over every sack of seed wheat, as it lies on the barn floor, and turning it repeatedly until every grain is wetted. It will dry of itself and be ready for sowing in an hour or two ; and it is best to prepare only enough for each day's sowing the night before. For wireworm or wheatfly there can hardly be said to be any remedy. Wheat is more liable to the former when taken after a grass or clover crop of more than one year standing. Hard rolling and trampling with sheep are adopted in the spring, when it is seen on examination of the dying plants that the wireworm is attacking the young stems ; but it is not often that much good is thus effected.

The spring management of the crop consists in rolling in dry weather and then either hoeing or harrowing. If the young plant is not in luxuriant growth a top-dressing of 1 cwt. or less of nitrate of soda mixed with 2 cwt. of common salt per acre may be applied broadcast with advantage during wet weather in March or April. A top-dressing of 30 or 40 bushels of soot per acre in spring is given in many districts with advantage. It is of advantage to have the young plant in vigorous growth, when the germ of the young corn is assuming the character for productiveness which it is ultimately to exhibit.

The crop is ready for reaping as soon as the berry or grain is hard enough to yield no milky juice when squeezed. The later stages of the ripening process do little else than thicken the bran coat of the grain and diminish its yield of flour. This subject was thoroughly investigated by the late Mr. John Hannan of Wetherby, who ascertained by rigorous experiment, that both the quality and quantity of the produce are improved by early harvesting. The crop is cut by sickle, bagging-hook or scythe, or by the reaping machine, which delivers it either in swathe or sheaf. Sheaf-binding reaping-machines, in which the bundles are tied either by string or wire, are now not uncommon. The crop is set up in stocks, five sheaves on a side, with or without top sheaves for further protection, until it is dry, and it is then carted to rick and thatched. The cost of cutting and stocking a wheat crop varies from 9s. to 20s. an acre, according to its bulk and condition. When tangled and laid by wind and rain, so that the reaper cannot be used, the latter price is sometimes unavoidable.

A great deal more than the usual care may be very usefully taken in the selection of proper seed. Major Hallett of Brighton has during many years urged on cultivators the importance of cultivating, and even educating, the seed we sow. By always selecting the ripest and best seed of the best ears of the best plants at his command, and cultivating them with extreme attention to every circumstance that would improve their productiveness, he has established what he properly calls a "pedigree" wheat in which good habits of growth and productiveness have been established. The principle he has adopted is open to the adoption of

every cultivator, and there cannot be a doubt that by his method many bushels per acre may be added to the produce of our wheat fields. He selected Hunter's wheat, named in our table above, as the original sort to be improved. There are other sorts equally deserving of attention in a similar way, and among them are some which might with advantage be more fully adopted than they are. Short straw sorts are desirable for highly cultivated land ; early ripening sorts for late-growing districts ; hardy sorts for hazardous climates. Scholey's Squarehead is very productive ; Sheriff's Bearded White—a short-strawed sort of irregular length—is productive ; Hallett's Pedigree is large-eared and productive. And other sorts, selected and improved by both enterprising farmers and energetic seedsmen, might be enumerated as desirable. The Chidham white wheat, the very highest on the list for quality, is not so productive or so hardy as some others. Rivetts and Cone—bearded wheats—with long but solid straw, are hardier and coarser than other sorts, but very abundant croppers, and often chosen when a second crop of wheat is taken on the same land.

Many of these sorts may be sown early in spring—even so late as February—as well as autumn with satisfactory results ; and there is an "April wheat" so called, a bearded, short-strawed red wheat, available for a still later seed time. The quantity of seed must be 10 pecks per acre for the late sowings, and the result is rarely satisfactory. A report in the "Agricultural Society's Journal," 1874, on the great extent of spring wheat which was sown in 1873, owing to the preceding very unseasonable autumn and winter, led to the conclusion that spring sowing results in a diminished yield ; and considering the relative prices of the two grains it will generally be better when the land is

otherwise fit, to sow barley in preference to wheat, even in February, and certainly in the later months. The average crop of wheat in this country may be put at 28 to 29 bushels per acre. Crops of 5 quarters per acre on good land are not uncommon, and crops of 6, 8, and even 10 quarters per acre have been known. There is thus a reward within reach of the careful and energetic farmer, who must aim at the greatest returns by means of a clean and enriched soil in good tilth, carefully selected seed sown in good season, attention to hoeing and cleaning the young plant in spring, and prompt harvesting as soon as ripe.

Barley occupies the third place in the list of cereals as regards the extent of its cultivation in this country. The two-rowed spring barley* is almost the only variety cultivated throughout the three kingdoms. A fine strain of this barley was brought out by Dr. Chevalier nearly fifty years ago, and it continues still to be more extensively grown than any other kind. Cheyne barley has obtained a considerable repute in recent years, and there are the Golden Melon, Hallett's Pedigree, and other varieties of two-rowed barleys that might be named, differing, it is said, in the length of ear, and quality of grain, though it is extremely difficult to separate differences inherent in sort from those which are due to the circumstances in which a crop has been grown.

There are also four and six-rowed barleys, and bere; the latter name being applied indifferently to all kinds having four or more rows in the ear. The rapid growth and early maturity of barley and of bere, especially the latter, which is now cultivated only in late and northern districts, are

* *Hordeum distichum*. Two-rowed Barley.—Natural order, GRAMINACEÆ.

advantages of some importance, for barley is often the last grain sown in spring, and usually the first reaped. In that respect it has the advantage of both wheat and oats, and it leaves the land less exhausted than either. The usual time of sowing is from the middle of March to the end of April, but, as a rule, early sowing gives the best quality, and in dry situations barley may be sown in February with advantage. The sowing of bere was formerly often not finished till May. Formerly 4 bushels an acre was the common seeding, but now $2\frac{1}{2}$ to 3 bushels are the usual quantities. If drilled, a smaller quantity suffices than when sown broadcast.

The soils best adapted for barley are good turnip lands—calcareous, loamy, and friable—and the crop generally follows turnips. On most of our light lands the turnips are consumed by sheep, and it is desirable to cover and preserve their droppings by a shallow ploughing soon after the sheep are removed. Barley is thus generally sown on the soft fresh furrow; and this also favours the coming away of the grass seeds which are often sown with this crop. When early ploughed the land may receive another cultivation, grubbing or scarifying, before putting in the seed; and it is of paramount importance to secure a good tilth—a fine and well pulverised soil being, if possible, obtained without stirring light soils too much.

Formerly barley almost invariably followed the root crops in the rotation; but where steam culture and the use of artificial fertilisers are adopted, the crop is very successfully grown after wheat. In fact, many of the finest samples of English barley are grown in this way. Deep draining and steam cultivation have widely extended the range of the successful cultivation of barley. The wheat

stubbles are smashed up, if possible whilst dry, during the autumn—in this way they present a large surface to the ameliorating influences of the winter rains and frosts. During the early spring, and when the land is dry, they are either scuffed or get a shallow furrow with the plough; the latter is to be preferred, as the crop delights in a “clean earth.” Of late years, large areas of barley have thus been grown in our clayland districts; and, thanks to the easier means of cultivation and manuring now available, the extension of barley cultivation has been carried on with perfectly satisfactory results.

The lighter soils in early districts are, however, the best adapted to the growth of the finer qualities of malting barley. It delights in a free open soil, being a shallow-rooted plant and a rapid grower. It requires a liberal supply of ready-prepared and easily assimilated manures within its reach, and thus is well adapted to follow the sheep-folds on the lighter soils. On the heavier soils, it pays well for a liberal dressing of artificial fertilisers. Superphosphate of lime, applied at the rate of 2 or 3 cwt. per acre at the seed time, is found to promote early ripening and productiveness; and if given with only half a cwt. per acre of nitrate of soda, it will generally ensure a crop of both straw and grain.

Barley has always been treated as especially capable of benefiting by what is called artificial manuring. This arises probably from the short period of its growth. In Mr. Lawes' experiments in continuous manuring, now carried on for more than thirty years, it appears that, whereas on the Rothamsted soil barley sown year after year without manure had in that time averaged only 19 bushels an acre, when 275 lbs. of nitrate of soda and 3½

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cwt. of superphosphate of lime had been annually applied, the crop had averaged $48\frac{1}{2}$ bushels an acre.

Although barley does not degenerate by successive cultivation on the same farm so rapidly as wheat and oats, a change of seed from one soil to another—as from gravelly soils to clays or loams,—is advantageous; and a change from localities of a different climate is also useful. The best grain for seed is plump and of a pale yellow colour. Barley yields less bulk of straw than wheat or oats, and its straw is of less value as fodder than oat straw. The produce of good barley land may be estimated at 36 bushels an acre, rising to 40 and 50 bushels per acre on fine land. In the years when the average acreable produce of Scotland was reported in the statistical tables, the county of East Lothian was returned at $39\frac{1}{2}$ bushels the imperial acre. Farmers who do not cultivate wheat rely a good deal on the barley crop for meeting rent and expenses.

Barley is not harvested till it is perfectly ripe—that is, when the ears droop and the reddish colour is gone off. It is of importance for the simultaneous action of the malting process, that the barley be all of one stage of ripeness, and that is to be attained only by making it all dead ripe. It is reaped either by the scythe or reaping machine. It may be mowed and bound in sheaves for about 10s. per acre. In the dry climates of England barley is frequently harvested loose in swathe, but this is to be deemed a rather slovenly plan, and one subject to waste; still, with good weather, it can be sooner carried thus than when in shock.

Barley has acquired a certain importance as an article of consumption, from its easy convertibility into malt and

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spirituous liquors. Inferior barley is generally ground into meal for feeding cattle and pigs; and nothing surpasses its value when boiled as a mash for horses after a hard day's work. It makes capital human food when made into pot or pearl barley. It was formerly and to a considerable extent ground into meal or flour, and used for bread; but this species of bread has long been given up for wheaten bread.

Oats.* This important grain is peculiarly adapted for temperate climates; and, being a hardy plant, it is better suited for poor soils and cold climates than either wheat or barley, and is consequently more easily cultivated. It is by means of the oat that grain growing can be extended beyond its present limits, into the newly broken-up moorland beyond the present limits of cultivation. The late Mr. Patrick Sherrieff, of East Lothian, a great improver of the varieties of all cereal crops, believed that with earlier varieties of oats, the home of the grouse and deer might yet be invaded. But the reverse process of laying down to pasture instead of adding to the arable surface is now more the order of the day. Friable soils are well adapted for oats; but they are also grown on stiff clays, as well as on both peaty and gravelly soils, and, in fact, upon all descriptions of ground. Oats are a gross feeding plant, and in this characteristic they exceed wheat and barley, requiring a larger amount of moisture than either. But a wet and cold summer, unless with the earlier varieties, leads to an untimely reaping time and a deficient harvest. Oats thrive best where a large quantity of vegetable matter is present in a state of decomposition, and they are

* *Avena sativa*. The Common Oat.—Natural order, GRAMINACEÆ.

very generally taken as a first crop on newly reclaimed land ; on such soils, indeed, the best crops are grown, both in respect to quantity and quality—and the older the pasture the better the crop. In Scotland oats occupy three times the area of wheat and barley together ; and in Ireland the ratio is four to one. In the North of England also the proportion of oats is large.

Seedsmen enumerate 30 or 40 varieties of oats, but many of them have little distinctive character, and others of them have become all but extinct. The kinds that maintain the best repute are the Poland, the Potato, Hopetoun, Angus, the Blainslie, Tartarian, Sandy, Tam Finlay, the Red and Dun oat, and several kinds brought out by Mr. Sherriff. The potato oat takes a high place—it has a plump mealy kernel, and is well adapted to the best soils ; but the straw is rather short compared with other kinds. The Hopetoun oat has a longer grain with awn, ripens nearly as early as the potato oat, and is not so liable to shed when exposed to wind. The straw is longer and not apt to lodge, but on indifferent soils the yield is sometimes disappointing. The Poland is a very early and short strawed variety. The Canadian oat is husky ; and although bulky crops of a heavy weight by the bushel are grown, its cultivation is not extending. Canadian oats sometimes weigh fully 50 lb. per bushel ; but 40 to 42 lb. per bushel is the common weight of most varieties. The Sandy, the Blainslie, and the Tam Finlay, are all useful varieties. The latter is the best established oat in the South-west of Scotland : it yields a fine fodder in its straw, and a good return of corn. And the recently introduced so-called Swiss oat, which has a like character, is highly spoken of. The white and black Tartarian oats are

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good yielding kinds, although somewhat light in the bushel. They both carry the ear on one side, are long in the straw, and well adapted for the poorer soils, and for soils of a peaty and marshy description. There are several kinds of winter oats, which are cultivated in the South of England, which have more or less merit, and have the advantage of being harvested early.

The earliest varieties are best suited for the higher class soils; and what are indefinitely called common oats are adapted for indifferent lands and climates, being hardier and better able to resist atmospheric changes, and less liable to shed their seeds in high winds. A change of seed is preferred from land of a clayey description, and from an early district. Oats do not degenerate so rapidly as other grains, but for light land a change of seed is advantageous every three or four years.

The oats cultivated a century ago in most of the ill-circumstanced parts of Britain were scanty, grey-awned, and of a very thin and poor description. Dr. Keith writes, in the beginning of the present century, that after the great frost of August in 1782 the native oat did not weigh over 20 to 30 lb. per bushel, and did not yield more than a half of the meal now obtained from the same measured quantity. A quarter of oats would then produce only 80 lb. of meal, instead of the 180 lb. which may be expected from a quarter now.

Oats are sown thicker than either wheat or barley, and 3 to even 5 bushels an acre are the common quantities of seed employed. The quantity established by experience as proper for particular districts should not be departed from, until the circumstances out of which the practice has arisen have themselves been altered. The very thin

seeding practised by the few will never be adopted by the many. The average yield of oats in good corn counties ranges from 44 to 56 bushels an acre, but occasionally 90 to 100 bushels an acre, and even more, are reaped from fertile fields. The months of March and April are the common seed time.

The Oat is, in the Northern Counties, sown almost invariably upon the ploughed-up grass of two or three years old. Ploughed firmly together and harrowed down, the oat finds here a suitable seed bed. In the Southern Counties it generally follows a root crop, as mangolds or swedes carried off. And where necessary, artificial manure may be used with advantage. Superphosphate of lime is a common top-dressing in fen districts, and nitrate of soda may be applied wherever it is desired to promote the growth of the straw.

Oats are better to be cut before they are fully ripe. When left till ripe the crop is very liable to be shed by a high wind. The straw of oats is far better fodder than that of wheat or barley, especially when they are early cut; indeed, sometimes the straw is almost as good as hay. Oats are almost universally cut with the reaping machine, then tied and put up into stooks to dry. In wet seasons and in late districts there is no better way of saving the crop, after being a few days in the stook, than building it in small stacks in the field, the builder standing all the time on the ground.

The finest strains of oats weigh 44 lb. and 45 lb. per bushel, and the common qualities run from 40 lb. to 42 lb., thin sorts from 36 lb. to 38 lb. Oats weighing 40 lb. per bushel are estimated to yield about 180 lb. of meal from the quarter on the average. Oats weighing 45 lb.

per bushel produce about 220 lb. of meal per quarter, from which it will be seen that the extra weight of fine oats is nearly all convertible into meal—the heavier the weight per bushel the greater the proportion of meal.

Oats are still to a considerable extent the bread-corn of Scotland, though not nearly so much used as formerly.

Rye * is the hardiest grain cultivated in Great Britain, growing better than any other on the poorest sandy soils. It was once extensively grown in English agriculture, but its cultivation, except for use cut green as forage, has much declined. It is still the chief crop and bread-corn on the wide sandy plains of the north of Europe. The 49,000 acres returned as the area of the Rye crop last year in Great Britain, is by no means the whole extent of its cultivation, more land being sown with Rye for a green crop than with Rye for a grain crop.

It may be grown on dry, poor and sandy soils, that will grow no other crop.

It is sown in autumn at the rate of 2 to 3 bushels an acre—the smaller quantity when intended to stand as a seed crop, and the larger quantity when intended for early green food in spring.

The straw is tough and pithy, making capital and durable thatch.

The cultivation and harvesting of the Rye crop is similar to that of wheat. It ripens in July and yields from 30 to 40 bushels per acre. When grown for forage it may be sown as early as August and cut in April, or, fed with sheep on the land, still earlier; it gives the earliest green food for use in stall or fold. Cut into chaff

* *Secale cereale*. Common Rye.—Natural order, GRAMINACEÆ.

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with hay or straw placed above it and below it in the chaff-box, it makes capital fodder for horses or cattle.

Beans * are a useful field crop, well adapted for strong as well as deep loamy and dry soils, especially those which contain a considerable proportion of lime. Where the land is thoroughly prepared, and horse and hand hoeing well attended to in early summer, if cultivated as a drilled crop—that is, in rows 20 to 30 inches in width—they form a good substitute for a clean fallow. They are however, more generally grown in rows not more than 15 or 18 inches apart, and it is not a bad plan to sow in double rows, *i.e.*, alternately 12 and 20 inches apart, enabling a thorough horse-hoeing on one side of each row. They are introduced in the same part of the rotation in clay land, as turnips, mangels, or potatoes occupy in light and friable soils. And it may be truly said that there is no better test of good clay land farming than the clean appearance of the bean crop at harvest, in the same way as a farmer of light land may be judged by his turnip crops. Beans are a capital preparation for wheat or other cereals, and in proportion to the success of the cultivation of beans on the bean land, and of the turnips on turnip land, will be the productiveness of the succeeding crops.

As we have said, clayey soils are best adapted for beans, and this becomes more obvious when we look at the distribution of the crop in the three kingdoms. In Scotland the Carse lands (alluvial clays) in the counties of Forfar, Perth, Linlithgow, and Stirling grow the largest proportion; and, in England the greatest breadth is grown on the heavy lands of Kent, Essex, Suffolk, Lincoln, and York.

* *Faba vulgaris*. Common Bean.—Natural order, LEGUMINOSÆ.

OUR GRAIN CROPS.—BEANS.

The decrease of the bean crop of late in the United Kingdom is very notable, for in 1873 there were 553,000 acres under beans, and in 1881 there were only 451,310 acres. The extremely wet character of recent seasons, making clay-land cultivation difficult, is probably enough to account for this.

A good many varieties of beans are cultivated in Britain, but the common Scotch or horse bean and the common Tick have been the longest known, and are the most extensively cultivated. The former, a prolific sort, grows to a height of 4 to 5 feet. The seed is large, flattish, and irregularly wrinkled on the sides, of a whitish colour, and black eye. The weight ranges from 62 lb. to 65 lb. per bushel. The common Tick bean is more cultivated in England; it is shorter in the straw than the so-called horse bean, and generally more prolific. The bean is smaller, and weighs from 63 lb. to 66 lb. per bushel, and is rounder and plumper. There are also the earlier and larger Mazagan, and many other garden varieties, of which the grain is larger and flatter. The Heligoland bean, adapted for field culture, a remarkably round bean, may also be named. The Russian or Winter bean is the hardiest of all the different kinds. The straw may be 4 or 5 feet long, and the seed is small.

Spring beans are sown as early as possible after the severity of the winter is over, and not later than March. When taken after wheat, as this crop generally is, the land should—after being scarified and cleaned—receive a good coat of manure, which should be ploughed under; and the subsequent cultivation will consist in the mere harrowing, and drilling, as soon as the land is fit in February. This crop does not generally answer to the stimulus of a top dressing during growth. Its produce depends on

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the general condition of the land as to fertility. Winter beans should be sown in October and in the first half of November, after the wheat stubbles which they follow have been cleaned, manured, and ploughed. Three to four bushels are the common quantities of seed per acre, but of course the quantity is somewhat regulated by the condition of the land, the size of the seed, and whether sown in row or broadcast. In some districts beans are sown on the top of raised drills containing manure—the land receiving very much the same cultivation up to seed-time as it does for swedes and mangel wurzel; and to permit free horse-hoeing, the drills are 24 to 30 inches wide. But the crop is more often sown by drill on the flat in well prepared soil, in rows varying from 15 to 18 inches apart. In order to judge of thickness in sowing, two samples were taken, the one of the horse bean, which weighed 63 lb. per bushel, and the other of the common Tick bean, which weighed 65 lb. In sowing the former broadcast, at the rate of four bushels per acre, we found that four and nearly one half beans were sown to the square foot of land; and in sowing the same measured quantity of Tick beans, there were five beans and nearly one half to the square foot.

Beans are cut down either by bagging hook, or reaping machine, as soon as the seed is sufficiently hard in the pod; and the crop is left on open bands to dry before being bound in sheaves. The sheaves are tied either with straw ropes or with ropes made with peas sown along with the beans. After standing in stook sufficiently long to get thoroughly dried, they are carted to the ricks and stacked. The produce of beans is generally from 25 to 35 bushels an acre. As much as 50 bushels is sometimes obtained; but 20

OUR GRAIN CROPS.—PEASE.

bushels, and even less, is as often the resulting product; and there is no marked difference whether the beans have been sown in autumn or in the spring. Early sowing is a great advantage when the season is mild in spring. Generally speaking, beans are a precarious crop, and in indifferent climates no crop is more uncertain in produce. They suffer from alternate frosts and thaws in early spring; and through the season they are subject to blight, mildew, and the attacks of insects, and especially from the black plant louse, which is often destructive of the leaf before the seed is fully formed, so that the crop is almost lost. When once ripe this crop will stand more untoward weather without material injury than any other corn crop.

Field beans are not used as human food, though they rank high in the scale of nutrition; they, however, are excellent food for all kinds of live stock; and with dairy farmers in the south-west of Scotland bean meal is the chief supplementary food of the cows. The straw, if well saved, is of considerable value, and when used as litter only, forms a rich manure when fairly decomposed.

Pease * succeed best in moderately light and friable soils of a loamy and calcareous kind, or where lime or chalk has been recently applied. Peas, like beans, were more extensively cultivated at the beginning of the century than they are now, and in recent years the decrease, as indicated by the statistical returns, is considerable. They are extensively grown in suburban agriculture for sale in the green pod. It is noteworthy that one-third of the whole area under this crop in Great Britain is cultivated

* *Pisum sativum*, the Common Pea. Natural order, LEGUMINOSÆ.

in the four counties of Kent, Essex, Suffolk, and Lincoln; but, taking the country as a whole, they are not often grown as a regular crop in the rotation. Many grow pease as a mixed crop with beans; about two thirds of beans and one-third of pease being the common proportion.

There is a multitude of varieties of the pea, if we include the kinds used in garden cultivation. The different kinds are distinguished by varying length of haulm, shape of pod and seed, earliness or lateness, and by their edible qualities. The varieties are also known by their colours—grey, brown, speckled, green, and white; but the original distinctions were merely grey and white. The white boiling peas are more delicate than most field varieties, and the coloured kinds are largely confined to field culture, for which the Partridge, Scotch grey, and early Warwick are well suited.

Most farmers cultivate pease in rows from 12 to 15 inches apart, in order that the land may be hoed and cleaned. In drilling, $2\frac{1}{2}$ to 3 bushels suffice, and the seed is deposited at a depth of from 2 to 3 inches. They are sown as early as possible in February when the soil is dry, and not later than the end of March. We have found several samples of grey and brown peas to weigh on the average 100 grains for every 30 peas (weight 63 lb. per bushel); and this, when sown at the rate of 3 bushels an acre, gives 9 seeds to the square foot. A smaller white pea contained 40 seeds in the 100 grains (weight 65 lb. per bushel), which when sown at the same rate per acre, corresponds to fully 12 seeds to the square foot.

Pease are an uncertain crop in their growth and produce, much dependent on the weather; and several kinds do not ripen well in moist seasons, as they are liable to fall down

before the pods are filled, often continuing to put forth blossoms till cut down. As a rule they pod better when the straw is not too long. They are cut with scythes, and harvested loose in bunches, which must be frequently turned, and are subject to suffer from wet weather, heat after rain making the pods burst and the peas to waste.

Immense quantities of the early sorts are cultivated for "green sale" near the large towns; they come away rapidly on light dry chalky soils or sharp gravels, and the earlier the crop the more profitable it is. The gathering is often done by contract at a fixed price for the four heaped bushels, which sell at 15s. to 18s. early in the season, when from 30 to 40 sacks an acre pay well. When cultivated and harvested as an ordinary crop by the farmer, 32 bushels an acre has been estimated as the average crop. Besides the precariousness of the crop as to weather, the yield is often greatly diminished by insect enemies.

The pea is the most nutritive of the leguminous crops, and very wholesome and substantial as food for man. Pea-flour, along with a mixture of oatmeal or barley meal, was once used in making bread; but wheaten bread has now supplanted it. Fine pease-meal combines the properties of easy digestion and rich nutrition.

Pease vary considerably in flavour and palatableness according to the soils on which they are grown and the manures applied to them; they do not require so much manure as beans. Independent of all manure dressings, it is generally asserted that good boiling pease are produced upon light and gravelly soils; and that after liming they are more agreeable to the taste than when raised after rich dressings of farm yard manure.

Pea straw is more valuable as fodder than the straw of any of the cereals. If well saved it is little short of the value of hay, and it makes capital fodder for all descriptions of domestic animals. Some farmers assert that stock thrive better when their ordinary food is supplemented with pease, than with other corn. Considering the value of both the pease and the straw, it is matter of regret that the cultivation of this crop should be decreasing. There is the further advantage in the growth of this crop, that turnips may be successfully grown after the removal of the earliest crops of pease in warm soils and climates.

We add here that questions as to the composition and nutritive value of both the grain and the straw of the several crops described in this chapter are answered in another volume of this series—"The Handbook of the Chemistry of the Farm."*

* "Handbook of Chemistry of the Farm."—Messrs. Vinton & Co.

CHAPTER IV.

OUR ROOT CROPS.

The Turnip.—Mangel-Wurzel.—Carrot.—Parsnip.—Kohl Rabi.—Potato.

Root or fallow crops are of the utmost importance to the fertility of the farm—wielding a powerful influence on the succeeding crops throughout the entire rotation—as constituting the main provision of cattle food, and thus of farmyard manure.

Making no pretension to scientific accuracy in our classification, we throw together in this chapter those crops which, in use and cultivation, and consequent place in the rotation, resemble the turnip or mangel-wurzel crop, without regard to the fact that they are not all strictly root crops. The tuber of the potato is an enlargement of an underground stem, and the bulb of the kohl rabi is an enlargement of the stem above the surface, but they are here classed together with the turnip, carrot, and parsnip. Of the 4,510,653 acres of so-called green crops in the United Kingdom, 2,227,050 are Swedish and common turnips, nearly 406,930 are mangel-wurzel, and 18,000 are carrot. Of kohl rabi there is no separate enumeration in the returns of the Board of Agriculture. Of potatoes there were 1,293,763 acres in the United Kingdom in 1881. Of this immense area more than half—753,060 acres—were

grown in Ireland. And of the mangel-wurzel crop 339,385 acres were grown in England.

The turnip* in one or other of its many forms has been cultivated in England for at least 150 years. About 1730, Lord Townshend, a Norfolk landowner, observing its value and the success of its cultivation on the Continent, introduced the plant on his own estate in Norfolk, and did what he could to promote its cultivation. The turnip is taken generally after the wheat crop in the rotation. It affects a lighter class of soils than those generally known as wheat soils—but during the long interval between wheat harvest and its own seed time (May or June), there is ample time and generally fitting weather in which to secure, even on the stiffer class of soils, the fine tilth which the seed requires to secure a rapid and successful germination.

Autumn cultivation, as soon as the corn crop is removed, should enable the thorough cleansing of the land from weeds. As early as possible the stubble should be thinly scarified or broad-sheared, well harrowed, and rolled, and the root and other weeds either burned or removed. They may be collected into heaps, mixed with lime and soil, and, being turned over several times during the winter, will form a useful compost in the spring. When the surface cleaning has been successfully accomplished, all light soils should be allowed to remain in this state until early in the following spring. Such soils, unlike those of heavier character, are deteriorated when ploughed up in the early autumn, and exposed to the wasting influences of the

* *Brassica rapa*. The common turnip.—Natural order, CRUCIFERÆ.

winter rains, which carry the manure constituents beyond the reach of the growing plants, and ultimately into the brooks and rivers. The land should in that case have a deep ploughing early in spring, and the succeeding operations of stirring and pulverising should be performed by the cultivator or grubber. By this means the moisture is retained, an important element in starting the young plants. The alternative plan of cultivation on the ridges or on the flat, has long been the subject of dispute. Climate, and especially the rainfall, is the chief agent in guiding the cultivator to his choice of either. Where the mean annual rainfall exceeds 24 inches, the ridge method of cultivation is to be preferred for the greater facilities which it affords for economising labour and for pulverising the heavier soils; but where the average rainfall is under 24 inches, the flat cultivation is most to be depended upon for a crop.

Taking the case now of the lighter soils under ridge cultivation, and supposing the land to have been cleaned in autumn, ploughed in early spring, and since stirred by the use of the cultivator or grubber, preparation has now to be made for the seed-time, which is the month of May in Scotland, or early in June in England. By either a double mould-board or single plough the whole surface is ribbed in drills some 26 to 28 inches wide. If farmyard manure is used it is then carted out and spread in the furrows, and covered in by splitting the ridgelets with the plough. The manure is sometimes tipped from the cart in small heaps and afterwards spread in the drills. Taking five drills in a breadth, the horse walks in the centre furrow; one or two men throw the manure from the cart into the several drills, women or boys follow with forks

breaking the lumps, and spreading the manure evenly in the bottom of the drills. Where the size of the farm is of sufficient extent to furnish a full set of men and horses, the whole operations proceed simultaneously; a man and one pair of horses opening the ridges, the manure carts and spreaders being followed by a second plough to cover in the manure; and 3 to 5 cwt. per acre of phosphatic manures are now almost invariably applied broadcast over the land, before the farmyard manure is covered. The action of the plough tends to throw this into the centre of the ridge, thus directly beneath the seed, and it is found to help the young plants through the early and critical stages of their growth. Then follow the seed drill and light roller, which complete the operation; and the seed, being immediately deposited in the moist soil, generally vegetates quickly. When turnips are grown on the flat by the aid of farmyard manure, the manure, carted out and evenly spread over the land, is covered in by a shallow furrow, and rolled down, and the seed is sown by the ordinary corn drill, fitted with a box specially constructed for the purpose. When artificial manures are applied in this case, they are either sown broadcast, or, what is preferable, mixed with ashes or other bulky material, and distributed, by the same drilling machine as the seed, through a manure box fitted with an independent row of coulters, which deposit the manure in front, and in the same line as the seed; the only danger to be avoided being that of the manure coming into direct contact with the seed. In some cases a water drill is used, and the dissolved manure may be washed into the land along with the seed. The distance between the rows varies in this case from 16 to 20 inches. If only it be perfectly covered the seed cannot

be deposited too shallow in the soil. A pair of light harrows or a chain harrow follows the drill, and if the land is dry it is good practice to finish off with a light roller. Everything, however, should be avoided likely to cause the land to bake, or form a smooth surface crust, in which case the young plants might have difficulty in forcing their way through. From 3 to 4 lb. of seed per acre should be used.

The preparation of strong adhesive soil varies greatly from that which we have just described. As soon as the corn crop has been removed, if the land is clean, a good dressing of farmyard manure should be applied and spread over the land, which should then, whilst still dry, be broken up by a deep furrow; and for this purpose the most expeditious and efficient implement is the steam digger. On soils of this character spring cultivation is fatal to success. If broken up early in autumn by the steam digger the land will generally be thrown up in a rough state, and will derive great benefit from the large surface exposed to the free action of rain and frost. If a favourable opportunity occurs during the early spring, the steam cultivator may be again used in order to level the surface; if this is carefully accomplished, it will insure a fine tilth when the time for sowing has arrived. The system of sowing on the flat is generally practised on strong land, though the ridge system of cultivation is not impracticable, the ridges being in that case formed and the manure within them applied before winter. When seed time has arrived, a chain harrow is then passed lengthways over them; the artificial manure is then sown broadcast in the ridges, and the loose pulverised soil is set up by passing the double mould

board plough between the ridges ; by this means a finely comminuted seed-bed is obtained without dissipating the moisture ; and the seed readily vegetates and draws sufficient moisture from beneath to support the growing plant.

These remarks apply generally to all varieties of the turnip crop. There is some difference in the methods of cultivation adapted to the Swedish and the common turnip. Preparation for the former, owing to its earlier cultivation, should be made as far as possible before winter. The farmyard manure for this crop is spread on the stubble and covered by a deep furrow early in autumn ; and when the seed time arrives, 3 or 4 cwt. per acre of artificial manure is either sown broadcast or drilled in with the seed. The best time for sowing the general Swede crop extends from May 1 to June 20, commencing with the former date in the north, and finishing with the latter in the south of the island. The best manure for the Swede crop is 10 ton per acre of good farmyard manure, and 3 or 4 cwt. of superphosphate, with an addition of 3 to 5 cwt. finely ground mineral phosphate. In the north nitrogenous manures seem to tell more favourably than in the south. Guano is there preferred as the main auxiliary, or nitrate of soda is added with effect to the superphosphate. The value of the farmyard manure greatly depends upon the food of the animals from which it is derived, and the care and protection bestowed upon it. When made in open yards and exposed to the deluges of rain-water thrown upon it from unspouted buildings, its value is greatly deteriorated. The best manure is made in covered yards, where fattening cattle have been liberally fed. And we deprecate the wasteful system of carting

out the manure during the winter, and placing it in heaps in the field, in order to save labour at a busy season. If carted out at all, it should be taken direct and at once spread on the land. But strawy, half-rotten manure, however well suited for ploughing in on strong lands in the autumn is unsuited for applying to turnip land in spring. Whether, however, it be made in open or covered yards or boxes, it is a good practice to have it turned over and thrown up into heaps, three weeks or a month before it is required for the crop, in order to promote fermentation: and the heaps should then be well saturated by pumping the liquid drainage from the tanks over them.

Success in obtaining an abundant growth from the seed, principally depends on the comminution of the soil and its retention of moisture. When the soil is in good condition, and the weather favourable, the young plants generally make their appearance in three or four days. During the early stages of their growth, before the rough leaf of the turnip plants has been formed, their most destructive enemy is the turnip fly (*Haltica nemorum*) which often devastates whole fields, scarcely leaving a single plant. We have several times saved the crop by having a light brush harrow drawn over the land twice a day, for several days; this disturbs the fly and enables the young plant to progress beyond their reach. Anbury, or finger-and-toe, is a troublesome disease, generally following a repetition of the crop at too short intervals on the land. The best means of preventing it is the application of chalk or lime to the soil. This should be done during the previous autumn on the stubble of the preceding corn crop: but it is also believed to have been beneficial when applied

as powder along the drill, as soon as the young plants were sufficiently developed to show the line of the rows.

The singling of the plants is carried out as soon as the permanent leaf has been fully formed. If the crop be in rows on the ridge the horse-hoe can be very early beneficially employed in the intervals between the rows. The more the land is stirred the more rapidly will the young plants progress; one of the disadvantages, indeed, of sowing on the flat is that the horse-hoe cannot safely be used during the early and more critical period of the plant's growth. We prefer singling out the young plants rather early. The work is best performed by the hand-hoe, the blade of which should, however, not exceed 9 inches in width. The plants are struck out the full width of the hoe: clever workers can leave a single plant with great certainty; but in general a small bunch is left at each stroke, and a boy follows and singles the plants, taking care to leave the strongest plant of each bunch.

The earth should be well removed from the stems in the act of hoeing, otherwise the plant is apt to throw out too many lateral roots, which detract from the value of the bulb. The horse-hoe should be freely used between the ridges both before and after the plants are singled. The best horse-hoe is a small grubber having five chisel-pointed tines; the depth to which the soil is stirred gradually increases from 4 to 6 inches or more, and may be frequently repeated with advantage even during the driest weather. The constant and deep stirring increases the absorptive power of the soil, and when efficiently conducted is the best known means of preventing mildew in the

Swede crop. It is found in the northern counties that continued growth, and thus immunity from mildew, may be promoted by applying some nitrogenous manure, such as a cwt. of nitrate of soda per acre broadcast, after one of the horse-hoeings in July or August. The system of deep stirring between the rows is more difficult to carry out when the crop is grown on the flat.

This root crop is of vast importance to the stock farmer: and quantity and quality are both essential conditions. The aim should be to grow a heavy weight per acre of roots of high nutritive value rather than to grow individual specimens of gigantic size. Medium-sized roots are usually of the greatest specific gravity. Although we have grown 32 tons of Swedes per acre on ridges 27 inches wide, with the plants set out 14 inches in the rows, as a rule we have grown the heaviest weights per acre and the best quality of roots at 18 to 20 inches between the rows, and 9 inches from plant to plant. These are the more common distances where drilled on the flat. But the great disadvantage of this method is, that the space between the rows is not sufficient to permit the practice of grubbing or deep stirring being successfully carried out.

Mildew often attacks the earlier sown crops. If by deep and frequent stirrings of the soil this destructive disease can be checked or prevented, early sowing is an advantage, for it enables the farmer to secure the crop before the short days and winter frosts set in. There are various methods employed of storing the crop: on land too adhesive for folding sheep, the entire crop is drawn off, and, for convenience of use, usually stored in large heaps near the homestead. The danger here is in making the heap too large, inducing fermentation and loss.

Undoubtedly by far the best practice on light and medium soils is to store in small heaps of one or not more than two cart-loads equidistantly all over the field where they grow. The bulbs are only topped, care being taken not to cut the leaves off too close to the crown ; the bulbs keep much better when the root fibres are left intact. The heaps should be formed of a conical shape, and covered with earth : on light easily worked soils the use of straw is quite unnecessary. Under ordinary circumstances Swedes stored in this way will keep perfectly sound throughout the winter. It is only where, having suffered from frost, or from becoming over-ripe, they have set up an incipient decay before being stored, that losses arise. When required for use the heaps are stripped of the soil, and the bulbs, first carefully trimmed with a hand trimmer, are cut or pulped and placed in the troughs, as the sheep are being folded over the land. A quantity of manure frequently adheres to the roots, hence it is essential that the roots trimmed off from the bulbs should be carefully spread with a shovel, otherwise rank spots in the succeeding crops will mark the site of each heap.

The average weight per acre varies with the season, with the quality of soil, with the quantity and quality of the manures applied, and with the skill bestowed on their cultivation. It varies from 10 to 30 tons—occasionally more—per imperial acre ; and the average produce of England may be taken to be about 15 tons per acre.

The cultivation of the softer common turnip differs from that of the Swede only in being generally sown from a month to six weeks later in the year. The hardy nutritive hybrid or yellow turnip, so successfully grown throughout Aberdeenshire and the East of Scotland, seldom

succeeds in the Midland and Southern counties of England. There are many sorts of both Swedish and common turnip, classed according to colour and shape, as globe, and tankard, purple top and green top Swedes; and yellow, common white globe, Lincolnshire red globe, stone, Pomeranian, stubble, and white and yellow tankard, all well-known varieties of common turnip. A portion of the common turnip crop may be sown in the end of April; and then it will be matured and ready for use by the following August. On purely tillage farms, where a large flock of sheep is kept, it is essential that a rotation of forage crops should be provided throughout the year; hence the necessity for early sowing a portion of the turnip break. For the main crop, the end of June and the beginning of July is the best time for sowing in English counties. This allows ample time for thoroughly cleaning and pulverising the soil, even when a spring crop, as of rye, vetches, trifolium or cabbages has been previously taken. The seed is usually drilled on the flat at intervals of 16 to 20 inches, and the rules of cultivation already specified are followed. Ten or twelve cartloads of farmyard manure are spread over the land, and covered in by a light furrow; and 2 or 3 cwt. of artificial manure is drilled in with the seed. The young plants should be set out not more than 9 inches from plant to plant. The less hardy varieties do not withstand the winter frosts, hence they are generally eaten on the land by sheep during the months of October and November. The hogs or young sheep are generally folded on the common turnips when first taken from grass. The roots are then seldom passed through the cutter, the sheep being allowed to crop off the tops and gnaw the bulbs. The sudden change from a meagre pasture to an abundant

supply of succulent food frequently induces attacks of diarrhoea; but this can be obviated by the simple precaution of having the roots pulled up several days or a week before they are used. By this means the sap becomes changed; and loses much of its irritant character. On the large sheep farms of Hampshire, Wilts, and Dorset, part of the latest sown turnips are left standing throughout the winter; and, in early spring, throwing up a profusion of top, they provide a succulent food for the ewes and lambs, and are a valuable adjunct to the Swede crop, bridging over an important season between the time the mangels and Swedes are finished, and the rye, tares, or clover are ready for folding off.

The mangel-wurzel* is the cultivated form of a wild sea-shore beet indigenous to many of the countries of the temperate zone. It was known as a garden plant long before its field cultivation was extensively practised. The roots are rich in saccharine matter, particularly those of the white variety, the cultivation of which, and the extraction of its sugar, is an important industry in many of the provinces of France and Germany.

The mangel crop is grown, to a greater or less extent, on every variety of soil; but those best adapted to its successful cultivation are deep adhesive loams. Hot and dry summers are favourable to its success as a field crop. On all adhesive soils autumn cultivation is of the utmost importance: the soil should then be thoroughly cleaned and freed from twitch and other root weeds, and should be broken up by steam power.

During the early autumn, and whilst the land is still

* *Beta vulgaris*. Common beet. Natural order, CHENOPODIACEÆ.

dry, a heavy dressing of farmyard manure should be applied—and either then or during the winter months, when advantage may be taken of frosty weather, the manure should be spread. Where practicable the ridge system of cultivation, in which the seed is planted along the top of a raised drill from 28 to 30 inches wide, is preferable, chiefly on account of the facilities afforded for deep and repeated stirrings of the soil. On strong clays spring cultivation is in most seasons fatal to the success of the crop: not only dissipating the moisture, but leaving the surface too rough and cloddy to provide a good seed bed, or insure a uniform braird.

The crop should be sown between the first week in April and the first week in May. Much in this respect depends on the season, soil, and climate. The crop pays well for liberal manuring: 12 tons of well-made farmyard manure applied during the autumn or winter; and a mixture consisting of 5 cwt. of mineral superphosphate, 1 cwt. of kainite, 1 cwt. of sulphate of ammonia, and 3 cwt. of common salt per acre, may be sown broadcast at seedtime and covered in by a turn of the chain harrow. If sown on the flat, the seed is deposited by the ordinary corn drill, to which a suitable seed box is attached. If on the ridge a drill specially constructed is employed. On small occupations the seed is sometimes dibbled by hand; but the practice cannot be recommended on a large scale, on account of the extra labour it entails; and as several seeds are apt to be dropped in the same hole, the roots of the young plants become intertwined, rendering the operation of singling both difficult and tedious. The seed is enveloped in a hard woody case or capsule, which requires to be well saturated with moisture before the germ can escape;

and in order to facilitate germination the seeds are frequently steeped in water for a period of forty-eight hours before being committed to the soil. When removed from the water they are spread thinly on a floor in order to drain off the superfluous moisture. We then frequently use a sufficient quantity of finely-powdered charcoal to mix with it, and form a thin coating to each seed. When prepared in this way the seed vegetates much more quickly than when it is sown in an unprepared state. Six or 7 lbs. is the usual quantity of seed employed per acre.

There are several well-known varieties in cultivation. On deep strong loams the Long Reds succeed well, and produce a great weight per acre; but if overtaken by early frosts they suffer severely, as they stand high above the ground. The Red Globe is less productive, and better adapted for light soils; the Orange and Yellow Globe are probably the most suitable for every variety of soils. They are hardy and heavy croppers, and for quality they cannot be surpassed.

Immediately the young plants, if on the ridge, have come into full leaf, and as soon as the weather is favourable, the horse-hoe should at once be set to work, at first only stirring the surface soil, but going deeper at each repeated operation. If on the flat, the hand-hoe should be early at work, to keep the weed growth in check. The plants generally succeed best when singled whilst small: the best distance from plant to plant is 12 to 16 inches. When the plants have made considerable progress in growth we have frequently found a dressing of 1 cwt. of nitrate of soda and 2 cwt. of common salt produce profitable results. The horse-hoe should be kept at work as long as the spread of the leaves will admit. The

mangel crop may be grown successfully from transplanted plants, showery weather being chosen for the operation. Care should be taken not to double up the tap root when planting it, nor to dibble the young plant in too deeply.

Under ordinary circumstances the crop will be ready to harvest by the middle of October. The work should be done in dry weather; the roots are pulled up by hand, and the tops may be either twisted off by the hand or removed by a knife. In doing this great care should be taken not to wound the crown of the root. During fine weather the roots are benefited by lying exposed several days before being stored. The chief danger is frost. Denuded of the protecting covering of their leaves, they are greatly injured if exposed to a sharp frost, even for a single night. None of the rootlets should be removed from the bulbs until they are required for use. On sound land they may be stored in small heaps in the field; on strong land they are generally carted off whilst the land is dry, and for future convenience stored in pits or heaps near the homestead. The heap is made 6 feet wide at the base—the roots neatly piled up on each side crown outwards, gradually tapering to a point at the top—being of a triangular shape when completed. It should then be covered with a thin coating of straw, and over this with 8 or 9 inches of soil smoothly finished off, in order to allow the rain readily to escape. Sufficient and suitable top ventilation should be provided by leaving the ridge uncovered with earth for a fortnight before finally covering it up, as there is danger of injury from fermentation. In the case of very severe frosts, when danger is apprehended, a covering of stable manure will generally prevent any damage. Large quantities may be safely stored together.

There is none other of the root crops which varies so widely in produce. The mangel crop in ordinary seasons may range from 15 to 50 tons of bulbs per imperial acre. These are exceptional cases. An intelligent and skilful cultivator, on a good soil, and with a favourable season, can grow from 30 to 40 tons per acre. The young plants are subject to the attacks of insects. The mangel wurzel fly (*Anthomya betæ*) deposits its eggs on the leaf; and as soon as they are hatched the larvæ feed upon and destroy the pulpy substance of the leaf.

For dairy cows, and for ewes during the lambing season, mangels are invaluable. Used in conjunction with corn or meal they increase the yield of milk. When carefully stored they will keep sound until midsummer. As the season advances certain chemical changes take place, which render the bulbs more valuable as food; and they are thus of great value in the summer time, as enabling the farmer to tide over periods of scanty natural supplies, whether for cows, grazing cattle, sheep, or pigs.

Carrots * can be grown successfully only on deep, well drained sandy loams. Deep cultivation is an essential point. The land should have a dressing of 12 to 16 tons of well-rotten farmyard manure applied in the autumn. The soil should be deeply and thoroughly stirred either by horse or steam power, the manure spread and covered in with a shallow furrow; it should be left in such a state as to require little labour at spring. The seed should be sown not later than the first week in April; the necessary quantity of seed is 6 lbs. per acre. They are sown on the flat, in rows 15 to 18 inches apart. We use from 3 to 4 cwt.

* *Daucus carota*. The carrot. Natural order, UMBELLIFERÆ.

of a similar mixture of artificial manures to that applied to the mangel crop. The hairy covering of the seeds causes them to adhere, hence the practical utility of mixing with dry sand before sowing. This operation is performed by mixing a quantity of clean sand and seed together, rubbing the mixture well between the hands; it is then moistened with water and spread out on a floor, where it is turned over daily and watered when necessary. It may remain in this state for a week or ten days, or until it is on the point of germinating, when it should at once be sown. The chief object is to enable the young plants to get the start of the weeds, which, under ordinary circumstances, often smother the tender plants. It is a good practice also to mix a small quantity of oats or turnip seed with the seed. These soon vegetate and point out the line of drill, and thus enable the hoe to be used long before the carrot plants can be distinguished.

It is essential that the soil be deep and thoroughly pulverised. The slightest obstruction causes the plant to throw out lateral shoots or forks, which greatly detract from the quality of the crop. The plants when singled should be set out from 4 to 8 inches in the rows, according to the sort that is being cultivated. Horse and hand-hoeing should be vigorously carried on as long as practicable.

There are several varieties in cultivation, amongst which the Altringham and the White Belgian are the most productive, and the most suitable to field cultivation. The former is long and tapering, and grows well out of the ground; the latter is superior in productiveness, its habit of growth is larger and less tapering, being of more uniform thickness. The produce varies from 10 to 20 tons per acre. Owing to the uncertain nature of the crop, the limited range

of suitable soils, and the expense of cultivation, the carrot occupies only a very limited area in the rotation. The crop should be ready for lifting by the middle of October. The plants are raised by the aid of a strong three-tined fork. This is thrust deeply into the soil behind the root, which is grasped with the left hand ; and the handle of the fork acts as a lever, to which pressure is applied, to loosen the soil. The tops are cut off with a sharp knife. If the weather is fine and free from frost, the roots are the better for remaining a few days in the field before being carted off. They are stored in heaps 5 or 6 feet wide at the bottom, piled in a triangular form, with the crown outwards ; if sand can readily be obtained, it is a good plan to mix a quantity with the roots. The heap receives a covering of straw, and is earthed over. Care should be taken to ensure ventilation. The principal insect enemy is the carrot louse (*Aphis dauci*), which attacks the crown whilst the plant is still in a young state.

The carrot is well adapted for fattening cattle : also for dairy cows, particularly where fine butter is the object. And it is useful for horses when given in moderation, otherwise its diuretic tendencies induce weakness.

The Parsnip * may be named as a field crop, though it is not extensively cultivated. It is capital food for dairy stock. Its cultivation is the same as that of the field-carrot. It is sown in February or March on clean and deeply cultivated loamy soil well enriched with manure, in rows some 15 inches apart. Some turnip seed or a few oats may be mixed with the 6 or 7 lbs. of parsnip seed which are sown per acre, so as by their earlier germination to mark the

* *Pastinaca sativa*. Common parsnip.—Natural order, UMBELLIFERÆ.

position of the future row and enable the early use of the hoe. The plants are singled out to 6 or 8 inches apart. They are harvested as carrots are in October ; or they may be left in the ground with safety, and dug as required. The root is wholly buried as it grows, and is thus able to withstand the frost. The Jersey cattle parsnip is the kind to sow for field use. A crop of 8 to 14 tons may be obtained, and they are a rich and nutritious cattle food.

Potatoes* continue to occupy a prominent place in agriculture, notwithstanding their great liability to disease. In 1891 there were 532,794 acres grown in Great Britain and 753,060 acres in Ireland. It is noteworthy that there is one acre of potatoes grown in Ireland for every six persons, and in Great Britain there is only one acre for every fifty of the population. This crop is certainly the most valuable of all our esculents. It yields a larger amount of human food on the acre than any other crop.

The soils best adapted for potatoes are friable, sandy, and loamy. On such soils potatoes are often grown systematically and extensively as a staple crop in the rotation ; but on strong tenacious clays with a retentive subsoil they do not thrive. Potatoes are often cultivated on moss or bog land ; in fact, they have a wonderful adaptation to soils of various textures and composition. They do well on virgin soils and turfy land ; and though subject to be cut down by early frost, and again to suffer in the tops by autumn frosts, potatoes are grown under a great range of temperature.

It is now 300 years since they were introduced into this country from South America, but they were not much cultivated before the beginning of the 18th century, and it

* *Solanum tuberosum*. Potato.—Natural order, SOLANACEÆ.

appears that they have been subject once and again to partial failure since their introduction. The diseases of the curl, the scab, and the dry-rot were not uncommon before the blight of 1846. The curl, by which the leaves and shoots become contracted and shrivelled, appeared first a century ago, and was very prevalent during the early part of the present century. It showed itself very early in the season, and sometimes to such a degree that whole fields were rendered in a great measure unproductive. In the failure of the tuber, by dry rot as it is sometimes called, the "set," though apparently sound, refused to germinate at all, or sent up a sickly shoot. This distemper was very prevalent in the years before the blight appeared, but when the entire and uncut tuber was used it seldom showed itself. The blight, however, has been the most formidable assailant of this crop. No prevention or cure for it has yet been found that can be relied on. Early planting of early sorts in early situations is the most likely method of avoiding its attacks; but new sorts every now and then present themselves which are capable for a while of resisting it. Good culture, a change of seed from a different soil and climate, the use of partially-ripe tubers and many other schemes, have been tried without permanent success.

The potato is propagated from its tubers, thus differing from every other farm crop; but it may also be raised from the seed in the apple on the shaw. Seeds gathered from the same stem or plant produce a variety of kinds, distinguishable alike by their shape, their eye, and their colour, as well as their appearance on slicing; but it rarely happens that more than a tenth of them are worth the trouble of propagating. When a good selection is made from the seedlings, they are often very prolific for a number of years,

and far less liable to disease ; gradually, however, losing their excellence in these respects.

In ordinary cultivation the tubers are used as sets, and seven to ten cwt. is the average quantity required for an acre, varying of course according to the size of the sets and the thickness of planting. Fair-sized tubers are cut previous to planting, leaving two or three good eyes in each piece. Small potatoes not large enough for division are planted whole.

The varieties of potatoes are endless, of every colour and shape ; but at the time of the great potato blight they dwindled down to a very few kinds. In recent years, however, they have again multiplied rapidly. White potatoes were scarcely saleable before the blight, but those of any other colour now do not command the price of whites. For convenience they may be classed into early, intermediate, and late varieties. In selecting sorts, several points merit attention ; and early maturity, quality, productiveness, and freedom from disease deserve first consideration. Rough-skinned potatoes for the main crop—and white-fleshed, equal, well-shaped tubers, with shallow eyes, and of a dry mealy quality—are to be preferred. A change of “ seed ”—as from heathy ground, from land that has been some years down in pasture, from newly-reclaimed land, or from a different locality and climate and soil—is desirable.

In the field cultivation of this crop three methods obtain—namely, the flat system, the ridge or drill, and the lazy-bed way. In the dry climates of England potatoes are mostly grown on the flat. The land is ploughed and sometimes dunged in autumn, and again the soil is ploughed or cultivated in spring, and put into a fine loose and pulverulent condition ; and the potatoes are planted, gene-

rally in every third furrow of an ordinary ploughing. When the plants come up, the land is kept clean and well-stirred by one or more horse and hand-hoeings in the course of the season, the rows being ultimately earthed up by passing a double mould board plough between them.

The ridge or drill system of culture is decidedly superior to cultivation on the flat, and it is the plan universally adopted in Scotland and the north of England. The crop is taken after the oat crop, which is always grown after clover and grass, and the land is often manured in autumn with from 18 to 20 tons of farmyard manure. If the spring is dry, and the land clean, the less tillage the light soils get the better, and the ridges are made with the ridging plough from 27 to 30 inches wide. From 3 to 5 cwt. of guano, or its equivalent in artificial manure, is applied to the acre when the potatoes are planted at from 10 to 14 inches asunder in the row. The sets are covered with the double-breasted plough by splitting and reversing the ridgelets, and after the lapse of ten days the saddle harrows are passed over them. The ridges are again earthed up by the plough when the plants appear. When the tops are all fairly up, the rows are carefully stirred by the hoe to eradicate weeds and loosen the soil, and the intervals are stirred and harrowed by a horse grubber. Again the mould is raised up to the ridges by the plough, and hand-hoeing, grubbing, and moulding up complete the tillage operations.

The lazy-bed system of culture, once much in vogue in the three kingdoms, although it has been severely criticised, has some advantages. No plan is better for wet bog land, low marshy places, and rough rocky grounds which obstruct the action of the plough. It consists in laying off the

ground in 4 or 5-foot beds, with intervening trenches from 18 to 24 inches in width. After the dung is laid on the beds, and the potatoes planted on the surface, the earth from the trenches is shovelled over the dung and the sets, which are covered to a depth of 3 or 4 inches. A second and further earthings may be applied as the plants advance in growth. The lazy-bed system is still practised in a number of places, and good crops are often obtained. It has two great advantages—the alleys draw off the superfluous water; and, in three successive years, by making the trenches where the beds were, the whole soil is cultivated to a depth of 2 feet or more; and this is certainly in accordance with the soundest principles of agriculture.

When the crop is ripe, which is known by the decay and falling off of the leaf, it should be dug out. The fork, the plough, and the potato-digging machine are variously employed in lifting them. The latter implement can only be utilised in light loamy and sandy soils; but very useful ploughs are now made for digging potatoes. The breasts of the ordinary ridging plough being removed, projecting tines are attached to the share, behind which is an oblique revolving harrow, and the two appliances combined raise the potatoes without bruising or injuring them. In storing potatoes, the main points to be attended to are, that they be protected from frost, that they be kept dry, and that fermentation (which is easily known by the forwardness of the shoots) be prevented in the pit. They are generally put up in long heaps 3 to 4 feet wide at the base, and raised to an apex like the roof of a house, and then covered with thatch. After thorough ventilation and drying, they are finally covered with earth, which is closely packed together, and laid on to a depth of 6 to 8 inches. It is

THE CROPS OF THE FARM.

now the practice to separate the diseased, and small and injured potatoes in the field from the marketable potatoes—a step which is indispensable since disease became prevalent.

In the best potato districts the produce ranges from 5 to 8 tons an acre; 10 and 12 tons are obtained in good seasons; but in years of rain and blight, 2, 3, or 4 tons may be all the return. The dressing for market reduces the quantity considerably, as it is the custom with many to pass the small ones through a riddle $1\frac{1}{2}$ inch in the mesh. Potatoes cooked in various ways form a large part of the food of man. Large quantities of starch also are annually extracted from potatoes, and not only used for domestic purposes, but also in the arts and manufactures. They are also useful as food for horses, to which they impart a soft and sleek skin. For swine they answer for both feeding and fattening, they are good cow food, and they may be used either cooked and mashed with chaff and other food, or raw and given by themselves.

Kohl Rabi* is a rapidly extending crop in the Midland Counties. It is a form of Brassica in which the enlarged stem is the object of the cultivator; and therefore it can hardly come in the list of our root crops. This enlarged stem, which assumes a globular or tankard form, is, however, to the sheep, and therefore to the flock-master, very much the kind of food which corresponds to a substantial Swedish turnip, and therefore in any practical arrangement of the crops of the farm, the two crops may be described almost together. The Kohl Rabi yields a crop of 20 to 25 tons of these stems; and they are cultivated

* *Brassica oleracea* (var.). Kohl rabi.—Natural order, CRUCIFERÆ.

and may be harvested and pitted very much as the turnip crop is. Sown either on the flat or on raised drills, the plants are singled out at distances of 10 or 12 inches in the rows, and horse and hand-hoed and treated to the end in very much the same way as the Swedish turnip, being either fed to sheep in the fold or carried home for cattle or sheep in yard and stall.

The rapid extension of its cultivation is the best proof that the merits of Kohl Rabi are becoming more fully appreciated; it succeeds well on lands which from repeated cropping have become turnip-sick. The young plants are sometimes raised in a seed-bed and transferred to their position in the field. Transplanting entails, however, so much labour, that it cannot be recommended on a large scale. The plant is a gross feeder, hence it requires a liberal supply of both farmyard and artificial manures. The crop should be sown early in May; and this is of considerable importance on large tillage farms in the Southern Counties, as it distributes the labours of a busy season over a wider period than where the swede is the only root crop cultivated.

The crop is hardier than the swede and mangel-wurzel, and less liable to suffer from insect attacks, quite as valuable as cattle food, and admitting of quite as thorough cultivation of the land during its growth. It prospers on all loamy soils in good condition, whether light or heavy. When cultivated by transplantation, the seed-bed may be prepared and sown in March, transplanted in May and June, and an early crop thus obtained in autumn.

CHAPTER V.

OUR FORAGE CROPS.

Clovers and Grasses.—The Vetch.—Sainfoin.—Lucerne.—Rye.—Rape.—Mustard.—The Cabbage.

WE refer in this chapter to a number of crops providing food for the live stock of the farm by their leaf and stem, which may be either cut and carried to the stall or grazed and depastured. The area occupied by these crops, including thus all clovers and grasses cultivated in rotation, probably exceeds 4,800,000 acres in Great Britain—7,000,000 in the United Kingdom. Of this extent, the “clover, sainfoin, and grasses under rotation” (so specified in the official returns to the Board of Agriculture) occupied 4,716,582 and 6,013,685 acres respectively in 1891, leaving 334,645 and 372,650 respectively in “vetches and other green crops (not root crops), except clover or grass,” besides an undefined extent in cabbages and rape, which we include in our present division, and of which, with kohl rabi not separately enumerated, there were 156,891 acres in 1891 in Great Britain—207,260 in the United Kingdom.

Clovers and Grasses.—These are unquestionably the most important of all forage crops, the clovers and grasses in rotation occupying nine-tenths of the whole area under

cropping of this kind in the United Kingdom. The cultivation of clover is a very important feature of English agriculture. Foremost among the varieties in use for alternate husbandry comes the broad or red clover,* which is a most valuable fodder plant, capable of yielding, if mown for forage or hay, at least two heavy crops in the year, leaving a large amount of root growth in the land as food for the succeeding wheat crop. From 12 to 16 lbs. of seed per acre, with a peck of rye-grass, is a proper seeding when the crop is intended to last only during the following year. It is often sown without any addition of rye-grass seed, and provides, when well-grown and well-harvested, admirable hay.

The so-called cow-grass,† similar in appearance and character, flowers later, and being perennial, is adapted for permanent pastures or for a clover layer intended to last three or four years.

The white or Dutch clover‡ is found growing naturally in most good old pastures, and is of excellent quality. Sheep are specially fond of it, and it is generally sown in all mixtures for permanent pasture or for several years, duration. The flowers, each at the top of a single stem, yield a large number of very small seeds. A top-dressing of bones applied to old turf will often bring up quite a thick carpet of this clover, the seeds of which have been lying dormant in the soil.

The trifolium incarnatum or crimson clover§ is sown in the autumn broadcast on a clean stubble, and simply harrowed in—about 20lbs. per acre—either alone or with Italian rye-grass, for cutting the following May. It is very produc-

* *Trifolium pratense*. Common red clover. † *T. pratense perenne*. Cow grass. ‡ *T. repens*. White or Dutch clover. § *T. incarnatum*. Crimson clover.—Natural order, LEGUMINOSÆ.

tive and is an excellent clover for one crop, or rather for one mowing, which should be taken early, as it becomes coarse and woody in the stem if allowed to ripen before being cut.

The alsike or hybrid clover* partakes of the branching character of the red clover, and has a light pink flower. It is of modern introduction, very hardy, and sometimes succeeds on land which will not grow red clover. It is specially adapted for land which is meant to be kept down several years, often growing quite as strongly the second and third year as the first.

The yellow trefoil or hop clover† is a free-growing early-flowering variety, which is generally included in any mixtures of seeds for alternate husbandry, producing good early sheep food.

The rib grass or narrow-leaved plantain is found growing abundantly in many of our meadows on marl or limestone soils; but it must be considered a weed, and ought not to have a place in mixtures of seeds.

Italian rye-grass‡ is a very quick-growing early grass, highly valued for producing early spring food or for sowing with clovers for an abundant crop of hay. When sown alone, from 3 to 4 bush. per acre are required; when mixed with clover seeds, from 1 peck to 1 bush., with 12 to 16 lbs. of clovers, is sown. It is specially adapted for growth upon sewage farms, liquid manure increasing its growth very greatly, three or four heavy crops a year being readily obtained. When cut and fed young, it is of excellent quality; but, if overgrown and suffered to ripen, it becomes wiry, benty, and coarse.

* *T. hybridum*. Alsike or Swedish clover.

† *Medicago lupulina*.

Yellow trefoil.—Natural order, LEGUMINOSÆ.

‡ *Lolium Italicum*. Italian rye grass.—Natural order, GRAMINACEÆ.

The common perennial rye-grass* is preferred by some for mixing with clovers, especially in moist and northern climates. It is not quite so early as the Italian rye-grass, and ripens for mowing about the same time as red clover.

The climate and soil of some parts of England are specially suited to the growth of clovers and artificial grasses. This is especially true of Cheshire, Lancashire, and North Wales. A mixture of 1 bush. of Italian rye-grass and 12 lbs. of clover seeds—in equal quantities of red clover, white clover, alsike, and trefoil—is often sown per acre for three years' use.

In alternate husbandry clovers and artificial grasses are nearly always grown with a corn crop—generally barley or oats—being sown just after the corn has been harrowed in, and simply rolled; or, after the corn is well up, it may be sown on the surface and rolled in. The quantity of seed required is 1 to 2 pecks rye-grass and 10 to 20 lbs. clover seed per acre. A barrow drill, taking a width of 4 or 5 yards at a time, is commonly used. In some districts these seeds are sown in August without a corn crop, immediately after the land has been cleared of a crop of early potatoes. When sown with a corn crop, a dressing of good dung, or 5 to 10 cwt. per acre of bone dust applied to the young plants in the autumn, after the corn is cleared, is of great benefit to the plant, and is specially desirable when it is intended to keep the land in “seeds” for several years.

The Vetch.†—There are two varieties of the cultivated vetch, scarcely differing in appearance, one of which is

* *Lolium perenne*. Perennial rye grass.—Natural order, GRAMINACEÆ.

† *Vicia sativa*. Common vetch or tare.—Natural order, LEGUMINOSÆ.

known as the winter and the other as the spring variety. Undoubtedly the winter variety has acquired its hardy habit from repeated winter sowing.

For a useful forage crop, the vetch is invaluable. The winter variety will, where the land is in good condition and favourably situated as to climate, often be fit to cut by the end of April. Mixed with hay or straw, and cut into chaff, the mixture is most valuable for horses, cattle, or sheep. In the Southern Counties, vetches are eaten on the land by sheep. The winter variety is put in during September and October, in successive sowings, in such breadths as will meet the requirements of the following spring. The plant succeeds best on strong loams and tenacious clays. The land should be clean and in good condition. The crop is usually grown on a clean wheat stubble, to which a heavy dressing of farmyard manure has been applied, covered in by a deep furrow. The seed is sown either in rows some 8 inches apart, or broadcast, at the rate of $2\frac{1}{2}$ to $3\frac{1}{2}$ bush. per acre, and harrowed in. Spring vetches for a first sowing are planted early in February, or as early as the season will permit; but, for a succession for summer feeding, the sowings may be continued till June is far advanced, at intervals of two or three weeks. Horses thrive well upon vetches, and on strong land tillage farms we know of no better or cheaper method of summering the horses than that of keeping them in the yards on vetches, along with a small quantity of dry food. A valuable addition to the manure heap is thus obtained in May or June. When eaten off or cut in April, May, and June, vetches may on suitable soil be succeeded by turnips; and when the weather has been suitable for obtaining a satisfactory tilth, turnips grown in this way, with a dressing of

superphosphate of lime, after a sheepfold on the vetches, will generally yield a satisfactory crop. On clay land the more common practice is to give a summer fallow after vetches as a preparation of wheat. It is proper to commence cutting the crop for forage before the plant is in full blossom, and so to arrange successive breadths for consumption that they shall be consumed before the seed is formed. When left for seed, they are cut and harvested as peas, as soon as the pod is full and the straw withered.

Sainfoin* is one of our most useful forage crops on all calcareous soils. It is generally sown to remain down for several years—as long, indeed, as the land remains clean and productive—being ploughed up, or perhaps pared and burned and afterwards ploughed, for a succeeding turnip crop, in the spring of its sixth or seventh year. But it has of late also occasionally been sown as clover is, to be kept down only for two years, during which, on suitable soils, it produces a large bulk of very wholesome and palatable food, which may be consumed, either as cut forage brought to yards and stalls, or by being grazed or folded, or by being made into hay.

About 4 bush. of the seed in pod (rough seed), or 20 lbs. of milled (clean) seed, are sown per acre in rows 6 or 8 inches apart—or it may be sown broadcast—with a barley crop after turnips, on land that has been well cleaned and folded with cake-fed sheep. It is treated in all respects as a clover crop—may be mown for hay the first year, and afterwards mown or grazed as desired. It ultimately generally succumbs to the smother of grasses which gradually invade it, owing, to some extent no doubt, to seeds in the hay given

* *Onobrychis sativa*. Common sainfoin.—Natural order, LEGUMINOSÆ.

to sheep folded on it, but principally to couch and other weeds and weed-seeds in the land when laid down. Where intended for only temporary occupation of the land, it is sometimes the practice to sow about 4 lbs. of hop trefoil seed with it, to help to make a full crop the first year, when the sainfoin alone has hardly come to its full productiveness.

It is best to take a turnip crop after sainfoin, and it is not uncommon to pare and burn it before the complete and deeper tillage and manuring for that purpose which it afterwards receives. When wheat is taken directly after sainfoin, it is apt to be infested and injured by wireworm; and this preliminary treatment and cropping is on that account to be preferred.

Lucerne * is cultivated to a considerable extent in Essex, Kent, and some other southern counties. It is a productive forage crop, yielding every year several cuttings of capital green food for both cattle and horses. Ten pounds of seed are sown in April, in rows 10 or 12 inches apart, on properly prepared land. It will afford a cutting in the autumn of the same year, which should not be taken close to the ground; and thereafter, during several successive years, it may be cut three or four times every season. A deep calcareous loam is the soil it likes. The land should be thoroughly clean, and it should be deeply cultivated and in good condition. It should receive an annual top-dressing of manure, and it is to be kept clean by repeated hoeings whenever the land is softened by rain, so as to admit of the hoe being used. Twenty to thirty tons per acre of most valuable forage for use, either in the cowstall or stable, are thus obtained in the season. The crop will,

* *Medicago sativa*. Common lucerne.—Natural order, LEGUMINOSÆ.

if kept clean, remain productive for six or seven years ; but it often becomes smothered in grass and other weeds, and has to be ploughed up in its third or fourth year

Rye * must not be omitted from the list of forage plants, although its cultivation as a grain crop has been described in a preceding chapter. Rye provides the earliest green food for sheep or cattle in the spring. Drilled, 3 bushels per acre in August or September, on any light soil, after any early harvested grain crop, and well manured, it will generally provide a bulky growth early in April, on which sheep may be folded, or which may be cut and carried to either stall or stable. The St. John's dry rye for even earlier sowing yields the earliest crop. The land may afterwards yield a turnip or cabbage crop.

Rape †—a most valuable crop for sheep keep, yielding the earliest autumn fold—seems especially adapted to fen and peaty soils full of vegetable mould. Well manured, and cultivated on the flat, in rows 15 inches or thereabouts apart, it yields in its leaf and succulent stem a large nutritive produce. After the land has been manured and cultivated during the spring months, about 4 or 5 lbs. of seed are sown, with some 3 or 4 cwt. of superphosphate, in June for the main crop, though any time after April it may be well to sow portions, in order to have a succession of food available for sheep from August onwards. The rows are hoed out as turnips are, but with a narrower hoe and without any formal attempt to single the plants ; and the intervals between the rows should be

* *Secale cereale*. Common rye.—Natural order, GRAMINACEÆ.

† *Brassica Napus*. Common rape.—Natural order, CRUCIFERÆ

horse and hand hoed. It is ready for the flock in about three months after sowing. It is well on all farms to have an early piece of rape to give sheep between grazing and the turnip fold.

Rape is cultivated to some extent on rich alluvial soils for seed. Sown late, as in July or August, it is cultivated as when intended for sheep food, but thinned out more severely in hoeing. It blooms in early spring, and is ripe and ready to be cut in July, when it is tied in sheaves to dry, and thrashed on a sheet in the field, yielding 30 bushels and sometimes more of seed per acre.

Mustard,* which had till lately been grown only for its seed on the richest alluvial soils in South Lincolnshire and elsewhere, has latterly, in one of its varieties, been used to some extent as a forage crop, or for the sheep-fold, or for ploughing under as a green manure. For either of the two latter purposes it may be usefully employed, after an early corn harvest, as of pease or winter beans—or even in early districts, wheat, barley, or oats. The white mustard is then to be sown broadcast, about a peck per acre, upon any soil in proper tilth. It will come rapidly, and be ready for folding sheep upon in eight or nine weeks from its seed time. If to be ploughed under as a green manure, this should be done while leaf and stem are succulent, and before the buds have gone into bloom. Employed in either of these ways, it is useful as an economizer of the soluble fertilizing ingredients in the soil, which, instead of being washed to waste during autumn and winter rains, are thus stored up in the growing plant, and returned to the soil, either directly or through

* *Sinapis alba*. White mustard.—Natural order, CRUCIFERÆ.

the manure of the sheep fold, for the use of the grain crop which is to follow.

Grown as a seed crop, the black or brown mustard * is sown, about a peck of seed per acre, broadcast in the end of April, on the richest available land, kept clean by hoeing and hand-weeding in May, and cut as soon as ripe, while the lower pods are turning brown. These are tied in sheaves and stooked, and when dry, threshed in the field, upon a board laid within a sheet or rick-cloth. When all the processes can be completed in dry weather, a good crop is very valuable.

The Cabbage.†—The Drumhead, or common cattle cabbage, is the variety most generally used for field culture. On suitable soils, and under good management, it produces an immense quantity of valuable food. Compared with the root crops the cost of its cultivation is much less. There exists amongst agriculturists generally a prevalent but erroneous idea that the cabbage is an exhausting crop. The plant is indeed a gross feeder, and abstracts during its growth a large amount, both of organic and inorganic matters, from the soil. But its power of digesting and assimilating mineral constituents increases the supply of available food ; and this, in turn, is available for the support of a new and succeeding race of plants. Exhaustion arises only when the crop is carted from the land where it is grown, and consumed elsewhere ; but this is no necessary part of farm management. The cabbage is best grown on deep adhesive loams resting on a well-drained subsoil. It likewise succeeds well on strong clays ; but deep cultivation and heavy

* *Sinapis nigra*. Black mustard.—Natural order, CRUCIFERÆ.

† *Brassica oleracea*. Cabbage.—Natural order, CRUCIFERÆ.

manuring are essential to success. The land should be deeply stirred early in the autumn, and should be free from root weeds. If the soil is of a clayey nature it should not be worked down fine, otherwise it is apt to run together, forming a smooth surface impervious to the air and action of the frost. The heavy dressing of well-rotted farmyard manure which should be given is most efficient when applied in spring directly under the plant. Cabbage succeeds best on raised drills. The manure is spread in the furrows, as in the case of the turnip or mangel wurzel, and then covered by splitting the ridglets. From 25 to 30 tons of well-made farmyard manure, and 2 to 4 cwt. of common salt, with 2 to 3 cwt. of superphosphate of lime per acre will together be a sufficient dressing. The artificial manure is best sown broadcast over the dung and covered in at the same time. The drills should be at least 30 inches wide, and the young plants pricked out at an equal distance on the tops of the ridges. Where a large breadth is grown it is economical to raise the plants on the farm in a sheltered spot for the seed bed—probably in the garden if the ground can be spared. The soil should be in good condition and finely pulverised. The seed is sown broadcast about the latter end of August, and will be fit to plant out by the middle of April or the beginning of May. The number required to plant an acre at the distance we have mentioned is 7000. The plants are drawn from the seed-bed and planted without delay. If the weather is dull and showery, so much the better. A thick puddle, consisting of a mixture of soil and artificial manure, with a sufficient quantity of water to cause the mixture to adhere to the roots, may be provided: and the plants are dipped in the mixture before being planted. The holes are generally made with a dibber.

Great care should be taken to place the young tap roots straight. The soil is pressed round the neck of the plant, and this finishes the operation. The weeds are kept down by the repeated use of the horse-hoe. The rows should be moulded up by the end of July. This is best done by passing a double mould-board plough between them, setting the soil close up round the roots. The cabbage is liable to the attacks of several insects, the most destructive of which are the milky and the black slug, the larva of a crane-fly and the caterpillar of the cabbage butterfly.

The crop arrives at maturity about the end of October, when the cabbages are cut off from the stems, removed from the field, and stored. They are arranged in conical heaps, care being taken to place the crown uppermost. By means of thorough ventilation fermentation can be prevented, and in this way they will keep well through the winter. The cabbage whilst growing suffers much more from excessive rain than moderate frost. The cabbage lends itself well to the process of preservation known as ensilage. The crop is taken up, passed through a pulper, and then firmly trodden down into a large brick tank, the top of which is hermetically sealed by a covering of clay, and loaded with a heavy pressure; the material is said to come out sweet and palatable after having been kept for three months. For sheep and dairy cows we know of no vegetable production equal in value to that of the cabbage. On good soils, under skilful management, from 50 to 80 tons per acre may be grown. With the extension of dairy farming and stock rearing, the cultivation of this crop may be very beneficially extended.

Besides the Drumhead cabbage, the thousand-headed kale another Brassica of the cabbage sort, is largely culti-

vated by some farmers for the sheep-fold. Sown, 4 or 5 lbs. per acre, on rich and well-prepared land in the end of April, it produces an enormous quantity of sheep-keep in the autumn. "The least known and most desirable of any green crop I have ever seen"—says Mr. Russell, of Horton Kirby, Dartford, Kent—"it is a plant that produces more food per acre than any other; does not disagree with any stock, nor does it impoverish the land. With me, it has never caused sheep or lambs to blow or scour. Eighteen perches a day, with a little oat-straw, have kept 270 sheep for three months without the loss of one." Mr. Russell sows a small extent on strongish land in August for use in April and May, and the bulk of his crop in April for use in the autumn and early winter.

CHAPTER VI.

ON LAYING DOWN LAND TO PERMANENT PASTURE

PERMANENT pastures are sometimes treated as yielding annually several cuttings of green food, removable to cattle in yard or stall; and they might thus have been named in the chapter on forage crops. They have, however, been referred to in a preceding chapter; and it only remains with regard to them to give such information as may be necessary on the subject of laying down arable land to permanent grass. The difference between good pasture land and poor pasture land, apart from the actual composition of grasses present in it (on which remarks are made on p. 4), and, still more, the main difference between land under a good permanent pasture and ordinary arable land, is the enormous quantity of fertilizing matter present in the former as compared with what is present in the latter. And the secret of the successful growth of the plants which make a pasture, as of all other plants whatsoever, lies simply in the provision for them within the soil of this abundant food for their growth and development.

On laying down land to grass.—An examination of the annual agricultural statistical tables shows that the proportion of grass land to arable in Great Britain and

Ireland has long been steadily increasing. It now amounts to more than one-half of the cultivated land of the United Kingdom. Various causes have contributed to this increase. Among them are the increased cost of horse and manual labour, the reduction in the price of home-grown corn, and a succession of deficient corn harvests, which have all tended to make arable farming in some localities unremunerative; and the enhanced price of store stock and meat has also tempted farmers to put more of their land down to grass.

This process of converting arable to pasture may be carried too far; for a larger stock may be maintained the year round, and a larger production of meat and dairy produce may be obtained upon a mixed arable and grazing farm, provided the arable land be good and suitable for the growth of roots, than if the whole farm were grass.

A glance at the returns of different crops in separate counties, in various parts of England, shows how the proportions of arable and grass are influenced by variations in climate and soil. Thus, in the eastern, southern, and south midland counties, where the climate is dry, and much of the land is light, the proportion of grass is but small; whilst in the north and west, where the rainfall is heavy and the summer climate cooler, grass preponderates.

There is much arable land which, from being very strong clay, and hilly, or in a cold, damp climate, is quite unprofitable in tillage; a higher expenditure of labour and manure than is required on better arable land only resulting in inferior crops of corn and roots. Such land, if well laid down to grass, may become in time useful turf, and its value to rent or purchase will thus be greatly enhanced by its conversion to pasture.

If ordinary land be seeded according to the tables of the seedsmen with the several sorts of grasses, each of the proper quantity, which are found in a good pasture, it will after the first free growth for a year or two generally diminish in productiveness—becoming very disappointing indeed in the 5th or 6th year—after which, if grazed and manured and liberally treated, it will begin to improve, and may, 8 or 9 years thereafter, attain whatever rank as a pasture shall ultimately belong to it. And if instead of sowing an elaborate mixture of seeds, the common practice be followed of sowing 8 or 10 lbs. of mixed clover seed, and some 30 lbs. of mixed “hay seeds” of unknown composition, along with a barley crop, and the subsequent pasture be afterwards liberally treated—mown the first year and thereafter not closely grazed (to which end sheep should not be allowed on it)—the land being periodically liberally dressed, and bone-dust or superphosphate being applied—the end will be that ultimately a fair pasture will be obtained. This will come about partly through the development of the best grasses which were sown, and partly by the gradual encroachment of the better grasses natural to the soil—*i.e.*, lying dormant in it—which have been able to hold their own, or even to do more than that, under the liberal treatment given.

The usual practice, however, when it is intended to lay a field down to grass, is, after draining and thorough cultivation, and manuring by means of a root crop folded upon the land with cake-fed sheep, to sow a suitable mixture of grasses and clover with a light seeding of barley. This is done when the land is in good tilth, in March or April. The clovers are sown by themselves, and the mixed grasses at a second operation. The barley produces a crop, which is

harvested ; and young cattle may keep the grass down the first autumn if there is an abundant growth : and the field may be mown the next year, being well manured in the autumn. It should thereafter be grazed annually—first with young stock,—the cattle receiving at the same time oil-cake or cotton-cake, thus enriching their manure, and adding to the fertility of the land. It should also be manured occasionally : bone-dust and superphosphate and kainite promoting the growth of the clovers ; and nitrate of soda and sulphate of ammonia promoting the growth of the grasses. In the course of a few years the land, if in a suitable climate, will become a good permanent pasture.

But in order to obtain on old tilled land a good turf as early as possible, it is the best policy to sow the seeds on land suitably prepared without any corn crop. One advantage of this plan is that if annual weeds spring up ahead of the clover, they may be destroyed without injuring the clover by mowing when 4 to 6 inches high, and any places in the field where the clover plant appears deficient can be re-sown at once. The risk of some of the small seeds being smothered by the growth of straw is also obviated.

It is most important for the land to be clean, firm, level, and of good tilth before sowing the seeds. If the land be unlevel or rough, many of the small seeds sown will not germinate. If the land be foul it may be better to delay the seeding a year, and take a crop of turnips or other roots, or even a summer fallow. Unless the field be in high condition, 2 or 3 cwt. per acre of Peruvian guano, or prepared bone manure, should be well harrowed into the soil before sowing the seeds. This dressing may be repeated with advantage, or 1 cwt. of nitrate of soda be substituted as a top-dressing when the young seeds are

3 or 4 inches high. It will generally be best to obtain a mixture of natural and artificial grasses and clovers specially adapted to the soil of the field, from one of our leading seedsmen, several of whom have bestowed great attention to the subject. About two bushels of grass seeds and 12 lb. of mixed clovers will be a sufficient seeding. The cost will range from 20s. to 35s. per acre.

The best time for sowing is from the middle of April to the middle of May, avoiding danger from spring frosts and summer drought. A dry, still day should be chosen, and it is better if there be a probability of an early fall of rain to start the seeds quickly. The land, being clean and level, should be harrowed with light harrows immediately before sowing the seeds, and rolled directly after. A very light harrow may sometimes be used with advantage after the seeds are sown, but unless lightly done some of the small seeds will be put too deep, and will not germinate. A seed harrow will be the best way of sowing the seeds, going twice over the land, once with the light grass seeds up and down the furrow, and then again the reverse way with the heavier clover seeds. An expert seedsman will, however, on a still day sow the seeds evenly by hand. If the land cannot be got into condition in the spring and early summer it may be sown in August. There is however a risk, in that case, of the small clover plants being destroyed by slugs in the following winter. Where it is desired to sow permanent grass seeds on land already sown with wheat, the end of March or in April will be a suitable time, as the wheat plant will in some measure protect the young seeds from damage by frost. A lightharrowing before sowing and rolling after will be all the tillage required.

When sown with spring corn the seeds may be put in

either directly after the corn is harrowed in, or in May when the corn is well up, the roller being always used to cover them. Two or three lbs. per acre of rape, is in some districts commonly sown without a corn crop, either with mixed clovers in alternate husbandry, or with permanent grass seeds. The rape and seeds are fed off together in the following autumn, and if cake be also given the young seeds are greatly enriched, and in fine weather the treading of the sheep benefits the seeds. Young seeds should not be closely grazed the first year, or be trodden in wet weather by heavy stock. After frosts commence in winter stock should not be allowed to go upon them. Different opinions exist as to the best mode of treating the seeds the following spring. They may either be mown early in June, taking care not to let them get overgrown, and afterwards fed, or they may be grazed throughout. A top-dressing of two to three cwt. of Peruvian guano, or $1\frac{1}{2}$ cwt. of nitrate of soda, will in either case be often applied with advantage early in April. If, as often happens when seeds are grazed, rough patches are left ungrazed, these should be mown off with the scythe.

Where the land is naturally poor, or has been exhausted by a long course of tillage, a very liberal treatment will be required to bring it into profitable turf. A dressing of good dung, or 6 to 8 cwt. of bones, repeated light dressings of quick-acting manures, such as guano or superphosphate, and the feeding of cake on the land, are all efficient means of improving the turf. Close feeding by sheep is deemed prejudicial, as they will pick out the clovers and finer grasses, and leave the coarser grasses to get the mastery. Where however cake is freely given, this objection is in some measure overcome, as the manure

greatly enriches and thickens the turf, and sheep when having cake will more readily eat coarser food.

In the wet climates of Cheshire and Lancashire, grasses in rotation, sown with clover and rye grass, are often kept down for 8, 10, and 12 years, and easily acquire the character of a good permanent pasture. In dryer climates the process is much slower. Mr. James Howard of Clapham Park, Bedford, in one of the driest districts of the island, described his experience in the 16th Vol. of the "English Agricultural Society's Journal" (1880)—as an ultimate success, after a considerable trial of patience. His most rapidly achieved success was obtained by the practice of so-called inoculation, which consists in ploughing narrow strips out of a good pasture, chopping them up and planting the bits, right side down, 9 inches apart, on good land which has been just seeded with mixed grass seeds, and rolling the whole down. The rooted grasses and the sown grasses soon make a sward, and the dying out of the grasses in the 3rd or 4th year, which is commonly seen when you depend wholly upon seeds, is not so observable. Mr. Howard prefers autumn sowings and plantings without a corn crop to spring sowings with Barley or Rape or Sainfoin. He recommends rather frequent small dressings of manure, than occasional large dressings. And he also advises re-sowing with so-called renovating clovers and grasses in the 3rd or 4th year after the original sowing; about 6 lbs. of seeds being thus sown per acre, and well harrowed, in wet weather.

As already stated, a large extension of pasture land has taken place in this country, the increasing cost of labour and the diminishing value of returns from arable land having led to this result. It is plain that those fields on

any farm which are most laborious by reason of the stiffer character of their soil, or the steepness of their surface, or their distance from the stable, should be selected when it has been at length resolved that a portion of the land hitherto cultivated shall be laid down to permanent pasture.

There is one portion of the permanent pastures of this country, which might, more properly than any other, have been referred to in the chapter on forage crops. The water-meadows, whether under sewage or under ordinary water, are often treated strictly as producing forage—successive crops being cut and removed annually. But we must be satisfied here with a mere mention of this subject. Ordinary water-meadows are grazed during the summer, and either mown for forage or, more generally, folded in early spring. The several furrows for the supply of the water along the ridge lines of the lands, and for the draining of the water between the lands, are cleaned and cut out in the autumn and made ready for the receipt of the overflow, after the first autumn rains have passed and carried away the weed seeds which they generally contain. Successive “drownings” at occasional intervals are given during the winter; and an abundant early growth especially valuable for ewes and lambs is obtained in spring.

For sewage irrigation, permanent grasses are not generally so well adapted. Italian rye grass is really the only suitable grass for this purpose. The lands made ready for receiving the water are sown in August with 4 bushels of seed; and the successive dressings of the sewage, when the young plant is fully up, before and during and after winter, result in enormous cuttings of rapidly grown and most succulent grass commencing early in April, and coming

every six or eight weeks throughout the summer ; some of them possibly 15 tons per acre, and all of them together amounting under ordinary circumstances to 40 to 60 tons an acre.

We do not think it necessary to fill our pages with elaborate tables of the particular combinations of seeds deemed suitable for laying down clays, sands, or limestone soils, to permanent pasture. That subject is treated with ample elaboration in every seedsman's catalogue. It must suffice to say that 30 to 40 lbs. of mixed grasses and some 10 lbs. of mixed clovers are a usual seeding, whether among a young barley crop or on a well-manured tilth in early summer. These seeds should include the Fescues (*Festuca*), rye grasses (*Lolium*), meadow grasses (*Poa*), cocksfoot (*Dactylis*), foxtail (*Alopecurus*), and the red, white, and yellow clovers, to which sweet vernal grass (*Anthoxanthus*), and perhaps crested dogstail (*Cynosurus*), are sometimes added. Six to ten lbs. in all of the several Fescues, 8 to 12 lbs. of the rye grasses, and 1 or 2 lbs. each of the other grasses named—with from 2 to 5 lbs. of each of the clovers, make a sufficient seeding for an acre.

The cost of laying down in the best manner poor arable land, and giving it in the first five years the manuring really required to insure the best result cannot be estimated at less than £10 per acre. When this outlay is undertaken by a tenant at will, he is entitled to great consideration at the hands of his landlord.

CHAPTER VII.

EXCEPTIONAL CROPS.

Flax.—Hemp.—Hops.—Buckwheat.—Jerusalem Artichoke.—The Lupine.—Chicory.—Gorse.—Canary-seed.—Comfrey.—Teazels.—Liquorice.—Market gardening.—Fruit farming.—Osier.—Maize.

It is proposed in this chapter, to give short instructions on the cultivation of a number of crops, whose cultivation is either confined to particular localities, suitable for them by reason of soil, climate, or local demand ; or which, having hitherto been grown only occasionally, and on an experimental scale, it may be desired to cultivate to a greater extent.

Flax* requires rich fertile land in good tilth, and in clean condition. It is generally taken after a corn crop, as wheat or oats or beans. The stubble should be well cleaned and manured before winter, and grubbed, harrowed and rolled in the following March, and from 6 to 8 pecks of seed are sown in the end of March or early in April, either in rows 8 to 10 inches apart, or broadcast ; and covered in by light seed harrows. It is of the utmost importance that good clean seed be used. The crop is hand-weeded in May. It gets into bloom in June, and may be pulled any time thereafter. If the finest fibre is desired, it should be pulled before the bolls or seed

* *Linum usitatissimum*. Common flax.—Natural order, *LINEÆ*.

vessels ripen. But these are generally allowed to get brown and ripe before the crop is harvested. It is pulled in handfuls, left to dry, tied in bundles, and either at once submitted to rippling for the separation of the seed, or stacked for after treatment. After being separated from the seed—which is effected by pulling the heads, a handful of stems at a time, through the steel teeth of a comb, placed upright across a horizontal board, on either end of which an operator sits—the straw is rotted, either by prolonged exposure to the weather on the surface of any grass field, or, in a more rapid way by soaking; and that is either done in a stream or pond, or in tepid water in a vat, the mass of sheaves in the water being weighted so as to keep the top just below the surface. In this way the woody part of the stem rots. It is then dried, rolled to break up the dried stems, and scutched for the removal of the rotten “wood” and the separation of the fibre.

The area of flax in the United Kingdom varies from 150,000 to 170,000 acres; of which all but 8,000 or 9,000 acres are grown in Ireland. The cultivation is somewhat diminishing in England, but it is fully maintained in Ireland. Four to six cwt. of fibre, and 16 to 20 bushels of seed per acre, are a good produce.

Flax has been lately recommended as an ordinary farm straw crop, to be grown for its seed and straw, the latter being sold—untreated in any way except by ordinary threshing for the removal of the seed—to the paper-maker who will give, it is said, at least £4 a ton for it in its natural condition. The seed may be used in feeding stock, providing as it does when crushed or ground, and boiled, a nutritive mucilage which may be thrown on chaff of hay or straw, and given to fattening cattle or sheep.

Clover and grass seeds are sometimes sown with flax, or after it in the end of April, and the clover crop then follows the flax crop in the rotation. Or the land may be sown with the scarlet clover (*Trifolium incarnatum*) after the flax has been pulled in July : and this provides generally a heavy cutting in the following May, to be followed by later sown turnips.

Hemp* is grown to some extent in rich alluvial soil in Lincolnshire and Dorsetshire, the land being prepared as for flax, and sown with about 3 pecks of good seed per acre, towards the end of April, in rows 18 inches apart. The plants are thinned in the rows to a foot apart. A very tall and bulky growth ensues which chokes all weeds, and the crop is pulled and stacked when dry, being afterwards subjected to a steeping process, similar to that described in the case of flax, for the rotting away of the woody part of the stem, and the separation of the fibre. A crop of 16 bushels of seed, and 6 or 8 cwt. of fibre per acre, may be looked for in favourable circumstances. A certain number of male plants which are recognizable by the difference of their inflorescence must be left in order to the formation of seed. They will ripen long before the female plants, and should be pulled first, so as to give the seed crop a better chance.

Hops†—to the cultivation of which we are about to refer in a single paragraph—are the subject of a whole library of books. Grown chiefly in Kent, Sussex, Hampshire, Worcestershire, and Herefordshire, this crop occupies an area

* *Cannabis sativa*. Common hemp.—Natural order, URTICÆÆ.

† *Humulus lupulus*. The hop.—Natural order, URTICÆÆ.

varying from 60,000 to 70,000 acres annually. Hops require a rich, and highly manured loam, elaborate cultivation, a sheltered position, and a suitable climate in order to success. The crop, varying from 2 to even 25 cwt. per acre, worth sometimes more than £20 a cwt., provides in successful years such an addition to the revenue of any farm suitable for its cultivation that it is very apt to absorb to itself an undue share of the means at the command of the tenant; and the general agriculture of a district where this crop prevails is apt to suffer in this way. A sheltered field, of naturally suitable soil—deep, fertile, and well drained—should be selected. It is deeply ploughed, subsoiled, and manured in autumn. If sheep are folded and well fed on the land in the first place so much the better. Cuttings, or shoots of any approved sort, which have been reared in a nursery are then planted in rows 6 feet apart, 3 being planted in every “hill,” 6 feet apart in the rows. Some growers plant two or three hills with male plants in order to ensure the proper fertilization of the seed. This planting should be done before winter, or early in spring. The wide interspaces are sometimes turned to account during the first year in the growth of potatoes or cabbages. Each hill has a short pole placed near it which is fixed before summer, and to which the young bine is tied. There is rarely any produce the first year. The spaces are well cultivated both ways, and heavily manured—the richest farm dung, woollen rags, guano, every available fertilizer being employed in quantities unknown in the case of any other crop. The ground is cultivated and manured in early spring, the hills severally tended with spud and hoe, useless suckers cut away, and the hills re-poled, this time with three longer poles to a hill. The intervals continue to be cultivated with

the "nidget," a so-called horse hoe ; the bine is tied to the poles—perhaps three bines to each. The hills are properly earthed up with shovelfuls of earth in June. There may be some trimming and pruning required in the case of strong growth in July. And the hops are hand-picked as soon as fit, *i.e.*, at a stage of ripeness which is recognizable only by experience. They are carried to the kiln or oast house, dried and packed, and sold. The poles are then stripped and stacked on the ground in conical piles, and they are looked over, and replenished before spring comes round, when they are again required.

The Hop is often the victim of mildew, and of various insect attacks ; the hop flea, and the hop aphid being the most destructive. No crop is more variable or hazardous, owing to the numerous and to a great extent irremediable character of its liabilities to injury.

Buck-wheat* produces a useful chicken corn and is available for that purpose on any poor sandy soil. A bushel of seed is sown per acre, in rows twelve to eighteen inches apart, late in May when all risk of frost is over. It flowers and ripens seed all through the summer, and may be cut towards the end of August, when the first flower seeds are ripe ; and it will yield a considerable produce, sometimes as much as 40 bushels an acre of seed, which is useful in the poultry yard. Buck-wheat is sometimes to be preferred to a late sowing of oats and barley, and if the land is clean and in fair condition, it may be followed by a corn crop.

Jerusalem Artichoke † may, occasionally, be a fit subject

* *Polygonum fagopyrum*. Buckwheat.—Natural order, POLYGONACEÆ.

† *Helianthus tuberosum*. Jerusalem artichoke.—Natural order, COMPOSITÆ.

for field culture, and will yield a surprising produce of tubers in very poor land. There are in most farms corners which would otherwise be waste land, which might be devoted to its cultivation with advantage. The tubers may be planted in March on any land which has been ploughed or dug, and manured. They may be dibbled in rows three feet apart and eighteen inches from each other in the rows. A great mass of stems comes from the tubers, and in France and Germany they are repeatedly cut down when young for use as fodder. If left till ripe, or till the leaf withers, they may be cut up into chaff and laid in the yards to be trod into dung: or perhaps burned to get rid of them. The tubers being dug may be stored in pits as potatoes. From three to eight tons may be grown per acre, and they may be given either raw or steamed to pigs.

The Lupine * may be grown either as a forage or a seed crop on our poorest sandy soils. About one bushel of seed is sown per acre, in May, in rows fifteen inches apart. There is sufficient growth in July when coming into bloom, for a cutting for forage purposes: or it may be left to seed: and it is available for profitable use in either way on land which would hardly yield a valuable crop of any other kind.

Chicory † may be grown for its roots, which when cut and dried and roasted, are of use for mixture with coffee, and as some think, the improvement of it. Though an English wild plant it was first introduced to English agriculture by Arthur Young in 1780, and was then grown as sheep food,

* *Lupinus albus* and *L. luteus*. White and yellow Lupine.—Natural order, LEGUMINOSÆ.

† *Cichorium Intybus*. Chicory.—Natural order, COMPOSITÆ.

flourishing on any kind of land. When grown for this purpose 4 lbs. of seed are sown per acre, in drills a foot apart, the plants to be afterwards singled a foot apart in the rows. It is to be kept clean by repeated hoeings, and, being perennial, will yield an abundant produce of leaf for several years, which is said to be good as sheep food. We have never seen it cultivated for this purpose. To prepare land for chicory as a root crop, it should be deeply cultivated, sown towards the end of May in rows nine inches apart, and cultivated as the carrot, being singled out to 6 inches apart in the row. All plants running to seed should be pulled. The roots are dug in October, the tops are cut off and the root is washed, cut into small pieces in a turnip cutter, and dried in an oast-house or kiln. The crop may be eight tons, or even more, yielding 18 to 24 cwt. of dried root per acre, which commands a profitable price.

Gorse* is recommended by enthusiasts for its production as a useful growth available as forage, after having been passed through heavy rollers, or bruised by mallet on a block. It is sown about 12 to 15 lbs. per acre, in rows 12 inches or more apart on any suitable land. Of course, land suitable for better and more valuable crops will not be selected for this purpose. If sown on land in good tilth the young plants will come up at once, and will be available for a first cut in the autumn of the following year. It will be best, however, to cut only every other row that year, leaving the alternate rows to be $2\frac{1}{2}$ years old before being cut; and thereafter cut every row in alternate years—each row yielding a twelve months' growth, which should be cut pretty close so as to hinder a shrubby

* *Ulex Europæus*. Common gorse.—Natural order, LEGUMINOSÆ.

growth of stem. The material cut is crushed by passing through a suitable chaff cutter and rollers, and is then readily consumed by either horses or cattle; and in hill countries, where the natural growth of gorse is to some extent already turned to account in this way, the systematic cultivation of this plant is a real agricultural improvement.

Canary-seed.*—A considerable area of this bird-seed is grown in Essex and Kent. Half a bushel of seed is sown per acre on rich land in good tilth late in February or early in March, in rows about ten inches apart. It requires repeated hoeings during growth; and, being left till the seed in the topmost heads is ripe, it is mown rather late in the summer, bound in sheaves and harvested as any other corn crop. The market price of canary seed varies so much from year to year—sometimes as much as from 40s. to £5 a quarter—that it will generally pay to keep it till a satisfactory price is obtainable. Thirty bushels per acre, weighing 60lbs. a bushel, are a fair crop. It takes the place of a corn crop in the rotation, and prefers a deep clayey loam.

Comfrey.†—The prickly comfrey has been of late recommended as a useful forage plant, yielding a large quantity of leaf, which is found to be very good food for either cattle or horses. It is perennial, and the plants are grown in rows 18 inches to 2 feet apart, and 18 inches from one another into rows. The land properly prepared and manured has the plants dibbled in. The intervals are kept clean by the hoe and hand hoe. A dressing of manure is

* *Phalaris Canariensis*. Canary-seed.—Natural order, GRAMINACEÆ.

† *Symphytum asperinum*. Prickly Comfrey.—Natural order, BORAGINÆÆ.

occasionally applied, and a succession of leaf gatherings may be made, which are very welcome in dry seasons, or slack periods of growth, when there is deficiency of green food on the farm.

Teazels* are grown on stiff clay soils in the southern counties. A portion of the field intended for them is cultivated and used as the seed bed—the seed being sown broadcast, about 2 pecks an acre early in April, and harrowed in. The remainder of the field may then be used for a corn crop. The stubble is ploughed and cleaned after harvest, and in October plants of teazel are pulled and dibbled in rows 16 inches apart, and 16 inches from each other. The seeded plot may be thinned in this way and worked over by hand with a long narrow spade, constructed for shallow work: and the plants which are selected must be taken from where the crop is thickest on the ground, so as to leave sufficient for a crop. The cultivation of both the seed-bed and the transplanted area is carried on during the following spring and summer, by repeated spadings which keep down weeds, and provide a good tilth in which the plant prospers. Some 16,000 plants are thus grown per acre. They blossom in July, and as soon as the bloom has left the heads, the work of cutting these heads begins, and continues for 6 or 8 weeks. The heads are taken to shelter—and tied in handfuls of 20 or 25 each, which are strung on poles which are placed under shelter. When quite dry, the work of sorting and repacking the heads on shorter sticks is proceeded with. A pack contains 40 of these staves, each carrying 20 handfuls of 25 heads, 20,000 teazels therefore in all; and worth

* *Dipsacus Fullonum*. The Teazel.—Natural order, DIPSACEÆ.

from £3 to £5. The crop varies from 5 to 10 packs per acre. The teazel is used for its stiff pointed calix husks in the cloth manufacture for combing out the surface of the cloth. The stems of the teazel are afterwards cut and tied in bundles to be burned out of the way, and the poor clay which has yielded a valuable crop, has so far benefited by the laborious cultivation during its growth, that it is rather improved than otherwise for the succeeding wheat crop.

Liquorice* attains, in this country, a limited cultivation, in rich and deep loams in one or two localities—near London, and in the neighbourhood of Pontefract, Yorkshire. The land is dug and trenched—even two and three feet deep, and deeply manured throughout its substance. A fertile soil is necessary, and 40 tons of good dung may be applied per acre. The land is planted with portions of the rhizome or underground stem of the plant, obtained either when a plantation is dug up for marketing, or annually by a pruning of the living plant. These rhizomes are cut up in pieces containing two buds each, and dibbled in March into the rich ground prepared for them, in rows 18 inches apart and 9 inches apart in the rows. You thereafter keep the land clean. The woody stem grows up almost as in an osier bed, and the plants remain growing for three years. They are then dug up. The roots, which may be, and ought to be, as large almost as a horse-radish, contain the sweet juice which is the object of their cultivation. The stems are used in thatching sheds, or for fuel. In digging up the crop the whole land is trenched 3 feet or more—nearly the depth to

* *Glycyrrhiza glabra*. Common liquorice.—Natural order, LEGUMINOSÆ.

which the root has grown, which is then pulled up. An immense value is obtained from a productive acre—for a crop of 3 tons or even 4 tons an acre are sometimes obtained, and the price of good roots is very high.

Market Gardening may be the subject of a page or two of this chapter on exceptional crops, for it has been recommended in many quarters, as possibly a help to the former when ordinary agriculture proves unprofitable. The one thing needed in order to success in any mode of cultivation involving continual sales of produce off the farm, is continual addition of manure to the farm; and this is the great difficulty in the way of market gardening. This and the absence of proper means for distributing the produce has tended to confine the space devoted to exceptional cultivation of this kind to a limited area around our large towns. And thus the market garden farmers and market gardeners situated within 15 miles of London have an immense advantage over all others beyond that pale. Still there is already much land far from London, and from other towns of importance, successfully devoted to the production of vegetables, whence the produce is taken to market by rail, and to which manure is brought by railway trucks, barges, or traction engines. Thus, near Colchester, 50 miles from London, and near Bedford, 50 miles from London, also at Sandwich in Kent, 80 miles from London, and at Gravesend, 25 miles distant, vegetables are extensively cultivated and pay a good profit in spite of the distance from the metropolis. Cauliflowers come up in quantities to London from Cornwall, and many also are sent from the neighbourhood of Mount Sorrell, in Leicestershire. We are quoting from a publication by Mr. Charles

Whitehead, of Barming House, Maidstone,* from which we shall take the enumeration of crops to which the attention of market gardeners, and of those farmers who unite this cultivation to some extent with ordinary farm management, is mainly directed.

“Upon some gardens, winter greens, coleworts, or ‘collards,’ or cabbages planted in the autumn are taken first. The greens and coleworts—which are simply cabbages cut in a premature state without hearts, for which some sorts especially suit, as the Blue Colewort, Cook’s Hardy Green, and the Rosette—are followed by peas, scarlet-runners, parsnips, carrots, French beans, lettuces, and radishes. Onions are either sown in the autumn after these crops, for ‘bunching’ in the spring or when they are intended for ‘bulbing’ they are sown in the spring after coleworts and other ‘green stuff.’ As much as 50 lbs. of Lisbon onion seed is sown broadcast per acre, the land being heavily manured with London dung, and frequently having a top-dressing as well. Carrots are successfully cultivated for “bunching” by market-gardeners, following sprouting broccoli, cabbages, or savoy. The best sorts for this purpose are Harrison’s Early Market and Carter’s Early Shorthorn, and about 12lbs. of seed are sown broadcast per acre. This is a very profitable crop and is only on the land a short time. Sown in April, it is frequently cleared away early in July, so that in growing seasons a crop of cabbages may be taken. Market gardeners do not grow many potatoes, as a rule. All they plant are dug as early as possible, and sent to market as

* “Market Gardening for Farmers.” By Charles Whitehead, F.L.S., F.G.S., Barming House, Maidstone. Reprinted from the *Mark Lane Express*. Effingham Wilson, Royal Exchange.

'young potatoes,' and in this way the potato disease is usually avoided ; but the crop is not generally of a very profitable character, compared with others. Cucumbers and vegetable marrows are extensively grown. These are set in rows, from 4 to 4½ feet apart. In most cases the seed is put at once into the ground, and it is exceptional to have transplanted plants. Sometimes the seed is 'speared,' by being put into damp flannel before it is sown, which gives it a start forwards, provided the weather is warm. All kinds of small herbs, salad materials, and flowers are grown by market gardeners in corners and out-of-the-way places. Some gardeners grow specialities, such as celery, radishes, and lettuces. The cost of cultivation of these kinds of vegetable is enormous. It is calculated that the average annual expenses of ordinary market garden land amount to £30 an acre. Manure alone costs £10 per acre, for every crop has a special dressing ; and most gardeners spend from £12 to £14 per acre per annum for labour. Rents are high and local taxes heavy. On the other hand the profits are good, and in some seasons they are very large for certain vegetables, such as onions, carrots, cucumbers, greens, and cabbages."

Fruit farming is a subject requiring larger space for fit discussion than can be afforded here. The growth of plums in orchards has largely extended of late years ; the growth of apples and pears both for table fruit and for cider and perry, has long been an established feature of English agriculture in the southern and western counties. The combined cultivation of small fruit, currants and gooseberries, with standard fruit trees in rows amongst them, is a department rather of market gardening than

of ordinary agriculture. In this case standards of properly selected apples, pears, or plums, are grown from 8 to 10 yards apart, leaving room for rows of bushes—as black red or white currants or gooseberries. On every farm there should be an orchard; and it ought to be well cultivated as a possible source of profit. An arable field of stiffish loam should be selected near the homestead for the purpose. And the sorts selected, whether plum, pear, or apple, should be grown each in its own row, so as to simplify the work of harvesting. The trees should be transplanted carefully, planted drilled each into a well dug plot, and supported by stakes. The land should be kept clean, and well cultivated and manured, and the intervals may be planted with currant and gooseberry bushes in rows, of which plants may have been grown from cuttings in the garden, planting them at wide enough intervals to enable easy and thorough spade cultivation amongst them.

The Raspberry * is in some parts of Kent and elsewhere a profitable crop on the farm. It is grown in separate trees, either staked or not, about 2 or 3 feet apart, in rows 6 feet asunder, from suckers or cuttings planted in the ground at these intervals, in October and November. It prefers a light soil, which should have been dug deep and been well manured to begin with, receiving also an annual dressing afterwards. The canes die after fruiting, and the young shoots of this year are the canes of the following year.

Strawberries † are largely cultivated with much advan-

* *Rubus Idæus*. Common Raspberry.—Natural order, ROSACEÆ.

† *Fragaria vesca*. Strawberry.—Natural order, ROSACEÆ.

tage near London. In some parts of Kent some growers have as much as 80 acres planted with them. They are grown from runners, which are abundantly produced every year in the strawberry garden. The strongest and earliest rooted plants obtained from runners are planted as soon as they can be obtained in June or July, in rows about 2 feet apart or more, at intervals of a foot or thereabouts. The land should be a naturally fertile, deeply cultivated, and somewhat adhesive loam; and its annual manuring should be liberal. Keen's Seedling, British Queen, Doctor Hogg, Elton Pine, and President, are among the best sorts, of which, however, there is every year an increasing number.

Osiers* are grown on low-lying or river-side ground, which is generally dug in beds 3 or 4 yards wide, with deep furrows left between them for drainage purposes, enabling the ready departure of flood-water. Cuttings 15 inches or 18 inches long are stuck into the dug ground, in rows of 18 inches apart and 15 inches from each other, according to the free-growing character of the sort. An annual growth of rods, from 7 to 9 feet long, takes place, and is cut after the fall of the leaf, at any time during winter. When sorts of larger growth are selected, a wider interval, as 2 feet in the row, and 18 inches from rod to rod, must be adopted. They are tied in bundles and placed lower end downwards in standing water, till in spring the sap rises and they are ready for barking and other preparation for use. The genus "*Salix*" contains many species, all of them adapted more or less for basket-making purposes, but differing very much in the quality of their rods.

* *Salix viminalis*. Common willow.—Natural order, **AMENTACEÆ**.

They go by various names: the "Spaniard" rod (generally coarse and inferior); the "Ornard" (excellent and tough), the "French" rod (good for fine work), the Stone Osier (a good sort), may be named. The cultivation of the osier may be seen well conducted in the Vale of Kennet and Thames.

Maize.—A word may be added here on the serviceableness of maize as a forage crop for use in English agriculture. Although we have rarely summers hot enough to ripen the grain, our climate will always enable the growth of the plant to reach a stage when its leaf and stem will provide useful cattle-food.

An early sort should be chosen, and well ripened seeds of it should be sown about the first week in June when all risk of frost has passed away. The seed should be scattered sparsely in rows about 18 inches apart, and the plants may be afterwards singled; and there will soon be an enormous growth of useful green-stuff to cut and carry to cattle, whether in field or yard, which will be of great service, especially in dry seasons.

CHAPTER VIII.

THE WEEDS OF THE FARM.

It may appear somewhat cynical to append a chapter on Weeds to a Handbook of the Crops of the Farm, and yet it is certain that they form almost always a large and important department of its vegetation, involving as much attention, anxiety, expenditure and labour, as any other. A list of them, therefore, and some general account of modes of propagation and destruction may be properly appended here.

A weed is a plant out of place. That is the simple definition of the term in its agricultural sense. A weed is, no doubt, a useless or noxious plant. But a plant that may fairly enough, according to the latter definition, be classed as a weed in one place, may not be a weed at all when grown somewhere else, or even when grown in the same place under different circumstances. All the pasture grasses, for example, are weeds when they come up in our cultivated fields. Moreover there is, perhaps, no plant which has not its uses in the economy of Nature, if we only understood them. It is therefore more correct to say, "a weed is a plant out of place."

The pertinacity and predominance of weeds is remarkable. In every district the pastures as well as the arable

lands are more or less over-run with weeds, and the crops greatly injured by them; yet the expense farmers are at for weeding is very considerable. We naturally associate weeds with poor and neglected soils; but weeds, like other plants, love best to grow in the fattest soils. Every soil, however, has certain weeds indigenous to it; and the natural habits of some of these plants, together with their indigenous character, render them so much hardier and more vigorous than most of our cultivated plants, that it often appears as if the more worthless the plant the more rapid and splendid its growth.

The weeds of the farm are a very numerous class, and many of them are very different in their natures. Some are annuals, others are perennials; some are only propagated by seeds, others have creeping roots and are propagated from these, and others again are propagated both by roots and from seeds. The seeds of some weeds, when covered too deep, or when the conditions of air, temperature, and moisture are unfavourable for their germination, will lie a great many years in the soil without losing the power of vegetating; others, if prevented from vegetating, will die in a few months or years. The seeds of charlock (*Sinapis arvensis*) are of the long-lived class; being very oily, they resist putrefaction when lying in a wet soil. This, though not the only cause, will often account for weeds of various kinds appearing in newly turned up soil that had not been disturbed for a long period, and when we are sure that no seed had fallen there for many years.

Weeds may be classified (1) botanically, by referring them to their natural orders; (2), according to the manner in which they are propagated; (3), according to the duration of the plants; (4), by arranging them according to

the soils they naturally inhabit; (5), by arranging them according to the crops they infest. The botanical classification would be best; but in a work of this kind a mere mention of the natural orders of the plants would not suffice, and a full account of them is impracticable. Nor will any other of these classifications by itself answer the purpose of this chapter. Some weeds are found on all soils and amongst all crops, and our limited space will not allow of repetition. The following list, however, will be found to include all the principal weeds met with on arable and pasture land. It gives (1), the English names; (2), the botanical names; (3), the soil or situation favourable for them; (4), the colour of the flower; (5), the time of flowering; and (6) the duration of the plant.

LIST OF WEEDS.

* The numbers express the months of the year: *e. g.*, 1, January; 2, February, &c.

† Annual, ○; Biennial, ♂; Perennial, ♀.

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	Time of Flowering.*	Duration.†
Adder's-tongue	<i>Ophioglossum vulgatum</i>	Mountain pastures	Green	4—6	♀
Agrimony	<i>Agrimonia Eupatoria</i>	Borders of Corn fields	Yellow	6, 7	♀
Bedstraw	<i>Galium palustre</i>	Moist meadows	White	7	♀
Bell-flower	<i>Campanula patula</i>	Pasture	Violet	7, 8	♂
"	" <i>hybrida</i>	Corn fields	Violet	8?	○
Bent-grass	<i>Agrostis vulgaris</i>	Sandy fields	..	6, 7	○
Bindweed	<i>Convolvulus arvensis</i>	Corn fields	Flesh colr.	6, 7	♀
Birdlip	<i>Galium tricornis</i>	Corn fields	White	7	○
Bitter Flax	<i>Linum catharticum</i>	Poor pastures	White	6—8	○
Blue Bottle	<i>Centaurea Cyanus</i>	Corn fields	Blue	7, 8	○
Broms-grass	<i>Bromus arvensis</i>	Corn fields	..	7	○
Broom-rape	<i>Orobanche minor</i>	Clover fields	Purplish	7, 8	♀?
Bugloss	<i>Lycopsis arvensis</i>	Corn fields	Blue	6, 7	○
Butter-bur	<i>Petasites vulgaris</i>	Wet meadows	Lilac	4	♀
Butter-wort	<i>Pinguicula vulgaris</i>	Bogs	Violet	5, 6	♀

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	Time of Flowering.*	Duration.†
Campion	<i>Lychnis vespertina</i>	Sandy fields	White	7	⊙
Candytuft	<i>Iberis amara</i>	Corn fields	White	7	⊙
Centaury	<i>Erythraea Centaurium</i>	Pastures	Rose	7, 8	⊙
Chamomile	<i>Anthemis arvensis</i>	Corn fields	White	6, 7	⊙
"	" <i>Cotula</i>	Corn fields	White	6, 7	⊙
"	" <i>nobilis</i>	Gravelly pastures	White	8, 9	4
Charlock	<i>Sinapis arvensis</i>	Corn fields	Yellow	5, 8	⊙
Chickweed	<i>Stellaria media</i>	Arable land	White	2, 10	⊙
Cinquefoil	<i>Comarum palustre</i>	Spongy bogs	Purple	6, 7	4
Coltsfoot	<i>Tussilago Farfara</i>	Calcareous elays	Yellow	3, 4	4
Corn Cockle	<i>Agrostemma Githago</i>	Corn fields	Purple	6, 7	⊙
Corn Centaury (Blue Bottle)	<i>Chrysanthemum Cyanus</i>	Corn fields	Blue	6—8	⊙
Corn Marigold	" <i>segetum</i>	Corn fields	Yellow	6—8	⊙
Corn Pheasant's Eye	<i>Adonis autumnalis</i>	Corn fields	Scarlet	5—16	⊙
Corn Poppy	<i>Papaver Rhoeas</i>	Corn fields	Scarlet	6, 7	⊙
Cotton Thistle	<i>Onopordon acanthium</i>	Rubbish heaps	Purple	8	8
Couch-grass	<i>Triticum repens</i>	All soils	—	6, 9	4
Crane's-bill	<i>Geranium pratense</i>	Moist pastures	Blue	6, 7	4
"	" <i>columbinum</i>	Corn fields	Rose	6, 7	⊙
Cresping Soft Grass	<i>Holcus mollis</i>	Light soils	—	7, 8	4
Crowfoot	<i>Ranunculus arvensis</i>	Corn fields	Yellow	6	⊙
"	" <i>acris</i>	Pastures	Yellow	6, 7	4
"	" <i>repens</i>	Pastures	Yellow	6, 8	4
"	" <i>bulbosus</i>	Pastures	Yellow	5	4
Cudweed	<i>Gnaphalium uliginosum</i>	Wet sandy soil	Yellow	7, 8	⊙
Daisy	<i>Bellis perennis</i>	Pasture	White	3, 12	4
Dandelion	<i>Leontodon Taraxacum</i>	Moist pastures	Yellow	3—10	4
Darnel	<i>Lolium temulentum</i>	Corn fields	—	6—8	⊙
Dead Nettle (white)	<i>Lamium album</i>	Waste ground	White	5, 9	4
" (red)	" <i>purpureum</i>	Waste ground	Purple	5—	⊙
" (Henbit)	" <i>plexicaule</i>	Corn fields	Rose	5—8	⊙
Dock	<i>Rumex obtusifolius</i>	Everywhere	—	7, 8	4
Dodder	<i>Cuscuta Trifolii</i>	Clover fields	White	8, 9	⊙
Dyer's-weed	<i>Reseda lutea</i>	Chalky soils	Yellow	7, 8	8
Eyebright	<i>Euphrasia officinalis</i>	Pasture	White	7, 9	⊙
Fat Hen	<i>Chenopodium album</i>	Waste ground	Green	7, 8	⊙
Feverfew	<i>Pyrethrum Parthenium</i>	Waysides	White	7, 9	⊙
Fleabane	<i>Pulecaria vulgaris</i>	Moist meadows	Yellow	7, 8	

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	Time of Flowering.	Duration.
Fleabane	<i>Erigeron acer</i>	Dry places	Blue	7, 8	8'
Fleawort	<i>Cineraria integrifolia</i>	Chalky soils	Yellow	5, 7	2'
Fool's-parsley	<i>Æthusa Cynapium</i>	Corn fields	White	7, 8	○
Foxglove	<i>Digitalis purpurea</i>	Hedge-banks	Purple	6, 7	8
Fumitory	<i>Fumaria officinalis</i>	Arable land	Rose	5, 8	8
Garlic	<i>Allium oleraceum</i>	Corn fields	Green	7	2
" (Crow)	" <i>vinale</i>	Meadows	Flesh colr.	7	2
Gentian	<i>Gentiana campestris</i>	Dry hilly pastures	Purple	9	○
Goat's-beard	<i>Tragopogon pratensis</i>	Pasture	Yellow	6	8'
Goose-grass	<i>Galium Aparine</i>	Fields and hedges	White	5, 8	○
Goose-tongue	<i>Achillea Ptarmica</i>	Moist places	White	7, 8	2
Gout-weed	<i>Ægopodium Podagraria</i>	Damp places	White	6, 7	2
Gromwell	<i>Lithospermum arvense</i>	Corn fields	White	5, 6	○
Ground Ivy	<i>Nepeta Glechoma</i>	Hedge banks	Blue	4, 5	2
Groundsel	<i>Senecio vulgaris</i>	Waste ground	Yellow	1—12	○
Hawk's-beard	<i>Crepis foetida</i>	Chalky places	Yellow	6, 7	8
Hawkweed	<i>Hieracium Pilosella</i>	Dry pastures	Yellow	5, 7	2
Heath	<i>Calluna vulgaris</i>	Heaths	Rose	6, 7	2
Hedge-mustard	<i>Sisymbrium officinale</i>	Commons	Yellow	7	○
Hemlock	<i>Conium maculatum</i>	Hedges	White	6, 7	8
Hemp Nettle	<i>Galeopsis Ladanum</i>	Corn fields	Rose	8, 9	○
Henbane	<i>Hyoscyamus niger</i>	Waste places	Straw clr.	7	○
Hogweed	<i>Heracleum Sphondylium</i>	Pastures and hedges	White	7	8
Horsetail	<i>Equisetum arvense</i>	Moist fields	..	3, 4	2
Knapweed	<i>Centaurea nigra</i>	Pasture	Purple	8, 9	2
Knot-grass	<i>Polygonum Aviculare</i>	Moist fields	White	7	2
Ladies' Mantle	<i>Alchemilla vulgaris</i>	Dry pastures	Green	6—8	2
Ladies' Smock	" <i>arvensis</i>	Corn fields	Green	5, 8	○
	<i>Cardamine pratensis</i>	Moist pastures	Purple	4, 5	2
Larkspur	<i>Delphinium Consolida</i>	Sandy fields	Violet	6, 7	○
Lousewort	<i>Pedicularis palustris</i>	Wet pastures	Purple	6, 7	○?
Meadow Rue	<i>Thalictrum flavum</i>	Moist meadows	Ochre	7	2
Meadow Sweet	<i>Spiraea Ulmaria</i>	Moist meadows	White	6, 7	2
Melilot	<i>Melilotus officinalis</i>	Corn fields	Yellow	6, 7	8'
Moss, Common	<i>Hypnum, &c.</i>	Poor and moist pastures.	—	—	2
Mouse-ear Chick-weed	<i>Cerastium triviale</i>	Pasture	White	5, 9	○
Mouse-tail	" <i>arvense</i>	Corn fields	White	5, 8	2
	<i>Myosurus minimus</i>	Corn fields	Yellow	5	○

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	Time of Flowering.*	Duration.†
Nettle	<i>Urtica dioica</i>	Hedges	—	7, 8	2
"	" <i>urens</i>	Waste places	—	6, 10	○
Nightshade	<i>Atropa Belladonna</i>	Waste places	Violet	6	2
Nipplewort	<i>Lapsana communis</i>	Arable land	Yellow	6, 7	○
Ox-eye	<i>Chrysanthemum Leucanthemum</i>	Dry pastures	White	6, 7	2
Ox-tongue	<i>Helminthia echinoides</i>	Bord. of fields	Yellow	7—9	○
Pasque Flower	<i>Anemone Pulsatilla</i>	Chalky pastures	Violet	4, 5	2
Pilewort	<i>Ranunculus Ficaria</i>	Hedge banks	Yellow	4	2
Pimpernel	<i>Anagallis arvensis</i>	Corn fields	Pink	6, 7	○
Plantain	<i>Plantago media</i>	Pastures	..	5, 9	2
Ploughman's Spikenard	<i>Inula Conyza</i>	Chalky pastures	Yellow	7, 8	5
Quaking-grass	<i>Briza minor</i>	Poor grass land	—	7	○
Rest Harrow	<i>Ononis arvensis</i>	Poor pastures	Rose	6, 8	2
Rushea	<i>Juncus conglomeratus</i> , &c.	Moist meadows	—	—	2
Saffron	<i>Colchicum autumnale</i>	Meadows	Purple	9	2
Sandwort	<i>Arenaria tenuifolia</i>	Sandy fields	Purple and white	6, 8	○
Saxifrage	<i>Saxifraga granulata</i>	Meadows	White	5	2
Scabious	<i>Scabiosa succisa</i>	Pastures	Violet	8, 10	2
Scorpion-grass	<i>Myosotis arvensis</i>	Corn fields	Blue	5, 7	○
Scurvy-grass	<i>Cochlearia officinalis</i>	Sea shore	White	6	○
Sedge	<i>Carex dioica</i> , &c.	Wet pastures	—	6—8	2
Self-heal	<i>Prunella vulgaris</i>	Damp pastures	Violet	7, 8	2
Shepherd's-needle	<i>Scandix Pecten Veneris</i>	Corn fields	White	6, 7	○
Shepherd's-purse	<i>Capsella Bursa-pastoris</i>	Corn fields	White	3—10	○
Sheep's-bit	<i>Jasione montana</i>	Dry pastures	Blue	6, 7	5
Sheep's-sorrel	<i>Rumex Acetosella</i>	Pastures	—	6, 7	2
Silverweed	<i>Potentilla anserina</i>	Moist meadows	Yellow	6, 7	2
Snapdragon	<i>Antirrhinum Orontium</i>	Corn fields	Purple	7, 9	○
Sorrel	<i>Rumex Acetosa</i>	Pastures	—	6	2
Sow-thistle	<i>Sonchus arvensis</i>	Corn fields	Yellow	8	2
Speedwell	<i>Veronica officinalis</i>	Bare ground	Blue	6—8	2
Spurge	<i>Euphorbia exigua</i>	Corn fields	Yellow	7, 8	○
Spurrey	<i>Spergula arvensis</i>	Sandy fields	White	7, 8	○
Stitchwort	<i>Stellaria media</i>	Moist meadows	White	6, 7	2
Stone-parsley	<i>Athamanta Libanotis</i>	Chalk	White	8	2
Succory	<i>Cichorium Intybus</i>	Sandy fields	Blue	7, 8	2
Thistle (Creeping)	<i>Carduus arvensis</i>	Bord. of fields	Purple	7, 8	2
"	" <i>pratensis</i>	Moist pastures	Purple	6—8	2

English Nams.	Botanical Nams.	Soil or Situation.	Colour of the Flower.	Time of Flowering.*	Duration.†
Thistle	<i>Carduus scaulis</i>	Pastures	Purple	8, 9	2
" (woolly-headed)	" <i>eriphorus</i>	Chalk Pastures	Purple	8	3
"	" <i>palustris</i>	Moist pastures	Purple	7, 8	3
"	" <i>nutans</i>	Waste places	Purple	7, 8	3
Travellers' Joy	<i>Clematis Vitalba</i>	Hedges	White	7	2
Viper's Bugloss	<i>Echium vulgare</i>	Corn fields	Blue	6, 7	3
Wild Oat	<i>Avena fatua</i>	Corn fields	—	8	⊙
Woundwort	<i>Stachys arvensis</i>	Corn fields	Purple	8, 9	⊙
Yellow Bartsia	<i>Eufragia viscosa</i>	Damp pastures	—	7—9	⊙
Yellow Rattle	<i>Rhinanthus Crista-galli</i>	Meadows	Yellow	6	⊙
Yellow-wort	<i>Chlora perfoliata</i>	Chalky pastures	Yellow	7, 8	⊙

This list might be greatly extended, but it is long enough, perhaps, to give the young farmer a fair idea of the number of his enemies which are for ever fighting for the mastery of his crops. And masters of the fields they will soon become if they are left alone. There must be no slack hand in dealing with them ;—no half measures will do.

"If you gently touch a nettle,
It will sting you for your pains ;
Grasp it like a man of nettle,
Then it soft as silk remains."

Weeds of all kinds are robbers ; occupying the ground, and feeding on plant-food and manure which was never intended for them ; thus reducing the crops and adding greatly to the expense of cultivation. Some of them, however, are not only injurious to the growing crops, but are damaging to samples of corn. Among the latter class are Corn Cockle (*Agrostemma githago*), Darnel (*Lolium te-*

mulentum), Melilot (*Melilotus officinalis*), Garlic (*Allium oleraceum*), and Goose-grass, Hariff, or Cleavers (*Galium Aparine*). The seeds of these weeds ripen at the time of corn harvest, and if once mixed with wheat or other grain at threshing, it is only those weed seeds which are lighter and smaller than the grains of corn, that can be separated in the process of winnowing. Wheat may be rendered perfectly useless for bread-making, from the loathsome flavour communicated by a large admixture of such seeds; and we have seen oats so full of Hariff-seed as to be quite unfit to put before horses. Again, some of the weeds mentioned, (Dodder and Broom-rape,) are parasites living at the expense of the clovers and other crops which are infested by them. Lastly, many of the weeds in pastures and hedges are highly injurious, some of them poisonous, to cattle; and with plants of this class the agricultural student should make himself perfectly acquainted.

Weeds are introduced into the fields, and spread over the farm in various ways; sometimes by the slovenly practice of throwing into the yard the seeds that are separated from the corn in winnowing so that they are carried out along with the dung. In too many cases the weeds are spread by the sown corn, clover, and grass-seed, being full of them. In this way dodder is often distributed with clover seeds; and the seeds of couch and other worthless grasses are mixed with those of the good grasses on which we depend when laying down land to permanent pasture. It is on this account impossible to be too careful at seed time that well screened clover seeds alone be sown, and that only grass seeds from clean crops be used. Then the seeds of some weeds, such as the

thistle, the dandelion, groundsel, and others, are furnished with a down by which they float in the air, and are carried, at times, to great distances by the wind. Birds often also help in spreading the seeds of weeds.

“One year’s seeding is seven years weeding,” says the proverb, and it is well to remember it. A single red poppy, left undisturbed, may ripen more than 40,000 seeds, each capable of producing a successor. In something less than seven years, that one poppy could produce plants enough to occupy every inch of the thirty and odd million acres of the United Kingdom, with red poppies. The cardinal point in weeding, then, is to prevent seeding.

Most of the annuals are propagated only from seeds, and grow chiefly amongst arable crops. It is worthy of notice that the seeds of most of them will lie in the ground for many years, if they happen to be placed deep; so that all land is more or less impregnated with them, and a fresh supply is produced every time the land is ploughed. Where the seeds will lose their germinating power after lying a certain time in the soil without vegetating, they may be destroyed by laying the land down to grass for five or six years. Those seeds that retain their vitality for an indefinite period may be got rid of by allowing them to germinate, and then destroying the young plants after they come up. Ploughing and inverting the soil is more favourable to the vegetation of weed seeds than merely stirring it with the cultivator; and at times it is desirable to promote the vegetation of such seeds as are in the soil, both by ploughing and manuring, in order that they may be destroyed before the land is sown for a crop. Where the crops are cultivated in rows there need be little difficulty in keeping down annuals and preventing seeding.

The same practice will be found effectual in dealing with many of the perennial weeds, but in this class there are a number of creeping-rooted plants, such as couch-grass (*Triticum repens*) &c., which are of a more troublesome nature. It unfortunately happens, that the more the land is worked, and the roots the more broken thereby, the greater the increase of such weeds. The only effectual mode of extirpating plants of this nature is by picking out the roots after the plough, or by forking them out by hand. The collected root weeds should be either burned or mixed with quick-lime to decompose them; in which case the compost may be afterwards applied to the land.

Arable lands may soon be rid of weeds by deep ploughing, hoeing (if done before the seed is ripe), hand-picking, and taking care that no weeds grow to seed. On grass lands, the best way to destroy weeds is by frequently cutting, or pulling them up by the roots. Cutting is necessary at least to prevent seeding. When hand-pulling is adopted it will be done with most ease and success after a shower of rain has moistened the ground. Some of the deep-rooted weeds in pastures, such as docks and thistles, may have to be dug out with the spud.

It will be seen that we have no easy or royal road to offer or suggest. Weeds must be got rid of by laborious removal or destruction, by bare fallowing if necessary, by taking more than one fallow crop in succession, by destroying the leaf repeatedly as it appears, and by pulling up the root whenever it is possible. Care, too, must be taken not to sow, as is often done, seeds of weeds with those of the crop under cultivation. Occasionally it is said perennial weeds have been destroyed by collecting them on the surface and burying them under a deep ploughing; and annual weeds

may be diminished and ultimately destroyed by giving repeated opportunities for their growth and then destroying them before seeding. In this latter way, too, many weeds will disappear from meadows if, instead of being annually mown, they are grazed and depastured for a succession of years. Liming will facilitate the destruction of many weeds. Draining will lead to the disappearance of many water plants, as Horsetail, Rush, and Sedge from grass lands. Specific manuring, too, will promote the growth of particular plants to the gradual extinction of others. The nitrogenous manures, as nitrate of soda and sulphate of ammonia, and gas water, promote the growth of grasses to the destruction of moss and other weeds; and bonedust and alkaline salts will promote the growth of clovers. In the case of arable farming, however, we must depend principally upon careful cultivation of the plant we desire, and laborious and direct extirpation of those we do not want, in order to a satisfactory result. And it is certain that it is in the long run much cheaper to be at the heavy cost, in the outset, of a thorough cleaning of the land—thereafter with little labour keeping it clean—than it is to follow the usual practice of accepting a certain quantity of Thistle, Dock, Couch, Charlock, and what not, as an inevitable annual growth, and incurring thereafter the never-ceasing expenditure and labour of an annual ineffectual fight with it.

CHAPTER IX.

ENSILAGE.

Introduction and Progress of Ensilage in Great Britain.—Silos.—Silage Stacks.—Crops for Silage.—“Sweet” and “Sour” Silage.—Silage v. Hay.—Feeding Value.—General Advantages.

THE practice of ensilage, which had previously been adopted to a certain extent in France and other European countries, as well as in the United States, was introduced to Great Britain about 1883. In 1884 there were 610 silos erected in Great Britain, and this number rapidly increased until 1887, when the number, as given in the Agricultural Returns, was 2,694. In the last-named year there were also recorded 1,362 “persons proposing to make ensilage in stacks.” The Board of Agriculture has ceased the publication of these returns, but, generally speaking, it may be said that while probably few, if any, more silos have been erected, and some of those existing have fallen into disuse, the number of ensilage stacks has greatly increased, and the preservation of green crops in this manner has become a recognised adjunct of farm practice.

The storage of grain in pits for long periods has been practised from time immemorial in Eastern countries, and it is the adaptation of this system to various veget-

able products, and especially to grass and other fodder crops, which is the practice now generally known as ensilage. It may be well to observe that the receptacle is a *silo*, the process of preservation is *ensilage*, and the product is *silage*. Silos have been made in all kinds of situations and of a large variety of materials, the cost ranging from 8s. up to as much as 50s. per ton capacity. In 1885, out of 970 silos in Great Britain 420 were entirely above ground, 450 partly below, and 100 entirely below the surface. Many silos were converted out of buildings erected for other purposes, and where this can be done conveniently and inexpensively it is no doubt preferable. One advantage of a silo is that if it is sunk, or partly sunk, dead weight can be conveniently used for pressure. Many mechanical contrivances for obtaining pressure have been adopted, some with considerable success, but the ideal form of pressure is undoubtedly the simplest, *i.e.*, dead weight. Another advantage—in some cases—of a silo is that the crop can, if desired, be chaffed before being put in. This is an especial consideration where thick-stemmed plants are pitted, while some users of silage prefer it always in a chaffed state.

When, however, it was found that silage could be made without a silo, *i.e.*, in a stack, a very great impetus was given to the system, and many farmers considered that it came for the first time practically within their scope. Silage stacks have several points in their favour as compared with silos. First, there is the saving of expenditure of capital needed for building a silo, and, secondly, there is the advantage that a stack can be

erected on any part of the farm most convenient for carting. Another advantage claimed for stacks, as compared with silos, is that the natural product, so to speak, in the former is "sweet" silage, while in the latter it is "sour." Without going at length into the chemistry of the subject, about which much has been written, it may be said that sour silage is that the temperature of which during the process of making has not risen above about 120 deg. Fahr. On the other hand, if the temperature is allowed to rise to about 130 deg. or 140 deg. the silage will be sweet. If it rises beyond, say, 160 deg. the other extreme is reached, and the silage becomes burnt and blackened. The secret of making satisfactory silage, therefore, is careful control of temperature, and this is obtained by regulating the pressure. In a silo the greater the pressure, and the more quickly it is put on, the "sourer" is the silage; if a sweet product is required it is often necessary to fill gradually and press very lightly, so as to allow the temperature to rise. In a stack, on the other hand, prompt and heavy pressure is necessary, especially in the case of a succulent or very damp crop, to prevent the temperature getting at once too high. With continuous, or practically continuous, pressure, from 80lb. to 140lb. to the square foot may be taken as usually sufficient. A crop of clover or grass between the time it is stacked and the time it is fully compressed will sink as a rule about three feet in every four; maize and corn probably rather more. The great difficulty to be overcome is that the sinkage continues for an indefinite period. It sinks at first very rapidly, and it will then continue to sink more or less for weeks and even months. Some crops no doubt continue to

sink for a much longer time than others. A stack of maize put together unchaffed in September was found to be still sinking in the following February.

All kinds of green crops, from the strong-stemmed maize to the soft meadow grass, can be satisfactorily preserved in silage. As to the condition of the crop, it must be borne in mind that the main object of silage-making is to provide a succulent food for stock. It follows, therefore, that the plant should be cut, not only in a living state, but at a time when it contains all its natural moisture. To secure this it is essential that the crop should by no means be allowed to get over-ripe when intended for silage. The following (say Messrs. Blunt and Rew in a pamphlet on the subject) may be reckoned as the best stages at which to cut the crops named :—

Grasses and clovers—as soon as they come into flower.

Tares or vetches—when the corn begins to form in the pod.

Rye, oats, and other cereals—when the corn is bursting into ear.

If a crop is put together in a wet or succulent condition, it is a mistake to trample it when stacking more than is necessary for the proper building of the stack. If, however, the crop is old and dry, the more it is trampled the better. To compare the relative value of sweet and sour silage it may be of interest to quote analyses made by Mr. F. J. Lloyd for Mr. George Fry, who was the first to preach the superiority of sweet silage.

A sample of sweet *trifolium incarnatum* silage and a sample of sour green oats and tares silage, both taken from the same silo, and both apparently excellent specimens of their respective kinds, gave the following results:—

	Sweet.	Sour.	" Moisture Sweet.	Free." Sour.
Moisture	70·92	75·20	—	—
Free volatile acid (calculated as acetic) ...	·09	·27	·80	1·08
Free non-volatile acid (calculated as lactic)	·27	1·08	·98	4·32
(1) Soluble albuminoids	·39	·24	1·84	·96
(2) Insoluble albuminoids	2·26	·72	7·78	2·88
(3) Amides, proteids, and other nitrogen compounds, carbo-hydrates, and cellulose compounds, etc. ...	23·55	20·26	80·98	81·84
(4) Mineral matter ..	2·52	2·23	8·67	8·92
	100·00	100·00	100·00	100·00
(1) Containing nitrogen...	·062	·039	·21	·15
(2) Do. do. ...	·362	·116	1·24	·46
(3) Do. do. ...	·359	·320	1·23	1·28
(4) Containing carbonic acid	·191	·09		
Do. silica ...	·235	·41		
Do. pure mineral matter	2·197	1·73		
Percentage of nitrogen present as albuminoids			54·0	32·0

It will be seen that the sweet silage was much superior in feeding value to the sour, and that there was in the

latter, as the late Dr. Voelcker pointed out, a large loss of albuminoids.

The following comparison of silage and hay—on the basis of chemical analysis—is sufficient to prove the theoretical value of the former as a food for stock. At the Smithfield Show of 1885, thirty-seven samples were sent in competition for a prize offered by the Ensilage Society for the best meadow grass silage. These were all duly analysed by Dr. J. A. Voelcker. In the *Field*, the thirty-seven analyses were epitomised in a table, which established a useful standard of value. The average percentages of the constituents of the samples were worked out as follows in their natural condition, and also when dried, with the addition for comparison of the average of fifty samples of meadow hay:—

	Average of 37 samples of Silage.		Average of 50 samples of Hay.
	In natural state.	Dried at 212° Fahr.	
Water	71.42	—	—
(1) Albuminoids ...	3.17	11.09	10.83
Indigestible fibre ...	9.33	32.65	30.35
Digestible fibre ...	10.39	36.35	} 51.53
Soluble carbohydrates ...	2.53	8.85	
Volatile acids ...	0.28	0.98	
Non-volatile acids ...	0.42	1.47	} 7.29
(2) Mineral matter ...	2.46	8.61	
	100.00	100.00	100.00
(1) Containing nitrogen	0.51	1.77	1.73
(2) Including silica ...	0.56	1.96	—

The feeding value of silage has been practically demonstrated by an overwhelming mass of testimony, but it will suffice to quote the account of some experiments made at the R.A.S.E. farm at Woburn in the winter of 1886-7. Twelve Hereford bullocks, two and a half years old, were selected. All received 3lb. decorticated cotton cake and 5lb. maize-meal per day. Six received hay *ad lib.*, and the remaining six silage *ad lib.* The silage bullocks commenced by taking about 38lb. per head, but this rapidly increased up to about 51lb. Of hay, the amount consumed per head was all through about 20lb. After eighty-four days of this feeding it was found that the gain per head daily had been :—

Bullocks receiving hay	...	...	1.96lb.
Bullocks receiving silage	...	...	1.98lb.

thus showing a slight advantage in favour of the silage. It may be added that the bullocks receiving hay drank nearly twice as much water as those receiving silage, all of them having free access to water.

A similar experiment, conducted contemporaneously under the auspices of the R.A.S.E., at Wilmington, on eight Welsh bullocks, brought out corroborative results. At the end of eighty days four bullocks receiving hay—with 3lb. of decorticated cotton cake and 3lb. of maize-meal—had gained on an average 1.3lb. per head per day; while four bullocks receiving silage—with a similar ration of cake and meal—gained 1.6lb. per head per day. In this instance the cost of

putting on the daily gain was estimated at, in the case of silage, $7\frac{2}{3}$ d., and in the case of hay, $9\frac{1}{2}$ d. per pound increase of dead weight.

The advantages of the system of ensilage are, in the first place, the possibility of saving the hay crop in a wet season. It is very certain, to put it at the lowest, that good silage is better than bad hay, and consequently the silage stack provides a safe resource whenever the weather prevents satisfactory haymaking. It must be borne in mind, however, that the question of silage or hay should be settled before the crop is cut. It does not answer to half make it into hay, and then as a last resource to make it into silage. Another advantage is that by growing green crops for silage it is not necessary to rely so implicitly on the costly and precarious root-crop for carrying stock over the winter; while the fact that a green crop can at any time be stored in a succulent condition until it is wanted, adds very much to the convenience of the grazier or dairy farmer and the elasticity of his resources.

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